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ABSTRACT

Initiated in 1979, this study obtained empirical evidence regarding the predictive validity of the restructured Graduate Record Examination (GRE) Aptitude Test. Of special concern were the questions regarding the contribution of the analytical section, as well as obtaining evidence of the correlational validity of scores on the restructured verbal and quantitative sections. The reported results are based on analyses of data for 100 small departmental samples (36 graduate schools) from the fields of English, education, history, economics, chemistry, mathematics, computer science, and economics. Following the descriptions of analytical rationale and assumptions, assessments of validity are based on samples of departmental data pooled by field. The results provide preliminary evidence of the validity of the restructured GRE Aptitude Test (and selected other predictors) for predicting first-year graduate grade-point average in samples of first-time graduate students entering in fall 1978, in subgroups defined in terms of sex, and in samples of self-identified minority students. (PN)

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GRE

GRADUATE RECORD EXAMINATIONS

A STUDY OF THE VALIDITY OF THE RESTRUCTURED GRE APTITUDE TEST FOR PREDICTING FIRST-YEAR PERFORMANCE IN GRADUATE STUDY

Kenneth M. Wilson

Gre Board Research Report GREB No. 78-6R
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October 1982

This report presents the finding of a research project funded by and carried out under the auspices of the Graduate Record Examinations Board.

EDUCATIONAL TESTING SERVICE, PRINCETON, NJ

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A Study of the Validity of the Restructured GRE Aptitude Test for Predicting First-Year Performance in Graduate Study

Kenneth M. Wilson

GRE Board Research Report GREB No. 78-6R

October 1982

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Acknowledgments

This study was conducted under the auspices of the Graduate Record Examinations Board whose sustaining support of validation research attests to a continuing interest in assuring that the interpretation of GRE scores can be based upon up-to-date and reliable information regarding their predictive validity. That this interest is shared by the graduate school community is indicated by the participation of over 100 graduate departments from 36 graduate schools in this study. Without such shared interest, concern, and support, this study would not have been possible.

At Educational Testing Service, Neal Kingston, Foster Schoenthaler, Frans Van Der Lee, and Cheryl Wild made it possible to collect, process, and analyze data using the GRE Program data files and validity-study routines; Richard Harrison and Lucy Mitchell programmed additional analytical routines needed for the study; Mary Jo Clark facilitated communication among parties concerned with the study; Rodney Hartnett reviewed the initial draft of this report and provided numerous helpful suggestions; Ruth Miller provided valuable editorial assistance; Frances Livingston provided secretarial assistance throughout; Christine Sansone and her associates in the manuscript-processing unit of the Division of Educational Research and Development prepared final copy for the manuscript.

These contributions are acknowledged with appreciation.

Kenneth M. Wilson

The Study in Brief

In October 1977 a restructured version of the GRE Aptitude Test was introduced that included shortened but comparable versions of the familiar measures of verbal and quantitative abilities and, for the first time, a measure of analytical ability. Based on research involved in its development, the analytical measure was known to be substantially correlated with the verbal and quantitative measures (in the .70 range) and significantly correlated with self-reported undergraduate grade-point average (or SR-UGPA). It was, therefore, expected to be positively related to first-year graduate grade-point average (GPA) and other criteria of academic performance in graduate study.

Despite this expectation, graduate schools were advised not to consider candidates' analytical scores in the admissions process until direct empirical evidence of their validity for predicting graduate school performance had been obtained. The present study was undertaken to obtain evidence regarding the relationship of GRE analytical, verbal, and quantitative scores to first-year graduate GPA in departmental samples from eight fields: English, education, history, and sociology (treated as primarily verbal in emphasis) and chemistry, mathematics, computer science, and economics (treated as primarily quantitative in emphasis).

Following the end of the academic year 1978-79, over 100 departments from 36 graduate schools supplied first-year graduate GPA for first-time graduate students who entered in fall 1978 (see Table 1 and related discussion).* Departmental samples were very small; for example, 59 of 100 samples had Ns ranging between 5 and 9, and 91 had Ns in the 5 to 19 range. Scores on the restructured GRE Aptitude Test and graduate GPA were available for at least five students in each of the 100 samples.

Other predictors that were available for at least five students in a department were GRE Advanced Test scores, as appropriate to a field (54 departments), self-reported undergraduate GPA as supplied by candidates when they took the GRE Aptitude Test (91 departments), and departmentally reported undergraduate GPA (62 departments; see Table 2 and related discussion).

Because of the small size of the individual departmental samples, averaging slightly more than 10 students with Aptitude Test score data, none of the departmental data sets were large enough to generate reliable estimates of the correlation between predictor and criterion variables. Estimates of predictor-criterion correlations based on a single sample with N = 10 (about average for the departments in this study) are quite unreliable (see Figure 1 and related discussion). However, by pooling results for several small departmental samples within the same field, it is possible to obtain much more reliable and interpretable estimates of predictor-criterion correlations (validity coefficients). A working assumption underlying this approach is that estimates of validity coefficients based on pooled results from several (say, D) different departments from the same field will tend to approximate those that would be obtained by pooling the results of D replications of studies involving samples of the same size within a given department (see text for elaboration of the pooling methods employed and the assumptions involved). The estimates of validity reported in this study were obtained by pooling correlational data for individual departmental samples within each of the eight fields of study, and then data were pooled across fields to provide evidence regarding predictive validity in two broad groups of fields, namely, English, education, history, and sociology (thought of as primarily verbal in emphasis) and mathematics, computer science, chemistry, and economics (thought of as primarily quantitative in emphasis). and mathematics, computer science, chemistry, and economics (thought of as primarily quantitative in emphasis).

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*Parenthesized references in this summary are to the body of the report where detailed treatment of the material alluded to may be found.

In addition, exploratory analyses (also involving pooled data) were made of the validity of the restructured GRE Aptitude Test and self-reported undergraduate GPA in subgroups defined in terms of sex and in samples of self-reported minority students.

Correlation of Individual Predictors with Graduate GPA

Table S.1 summarizes the basic correlational results obtained in the present study for the eight fields and the two broad groupings of fields. For comparison, the table also includes correlations obtained for pooled data for departments from the same fields in an earlier study that involved first-time students entering in 1974 and 1975 combined. Data for GRE analytical scores and self-reported undergraduate grade-point average were not available for the earlier study.

Regarding the new GRE analytical ability measure, the following observations are relevant:

- In three of the four fields designated as quantitative (all but mathematics), validity coefficients for analytical scores are slightly higher than those for quantitative scores and coefficients for both analytical and quantitative scores are higher than those for verbal scores.

- In the fields designated as verbal, the observed pattern of validity coefficients for verbal, quantitative, and analytical scores is not consistent; in the comparatively large education sample, the analytical score comes out ahead in the correlational competition with verbal and quantitative scores while, in history, the coefficient for the analytical score approximately equals that for the verbal score; the verbal score is dominant (and atypically high) in the pooled sociology sample (N = 44).

On balance, these findings suggest that, in the fields designated as verbal, the predictive value of the analytical score may tend to be about like that of the verbal score whereas, in the fields designated as quantitative, the predictive value of the analytical score may parallel that of the quantitative score.

In evaluating the observed validity coefficients for verbal, quantitative, and analytical scores, it is important to recall that departments were advised not to consider analytical scores directly in admissions. When a variable is considered directly in the selection process, the range of scores among enrolled students is reduced, and there tends to be a corresponding restriction in the correlation between that predictor variable and a performance criterion within the sample of students involved. Thus, in the circumstances, the analytical score probably enjoys something of an advantage by not having been directly involved in the selection process.

The additional predictors. With regard to the additional predictors, the magnitudes of the validity coefficients for the GRE Advanced Test scores in the present study and those obtained in the earlier study suggest the importance of including a measure of substantive achievement in a field as well as measures of developed abilities. It should be noted, however, that estimates of the validity of the GRE Advanced Test scores are almost always based on a selected subgroup of the individuals who present GRE Aptitude Test scores and that this pattern introduces elements of interpretive ambiguity when comparing the validity of the respective predictors. Observed validity coefficients for the self-reported undergraduate GPA are comparable to those for the departmentally reported undergraduate GPA. This indicates that, for research purposes, the self-reported index may be a satisfactory surrogate for the less-frequently available departmentally reported index.

Table S.1

Validity Coefficients Estimated Using Departmentally Standardized Variables in Pooled Departmental Samples, by Field: 1974 and 1975 and 1978 Samples

(Criterion is First-Year Graduate GPA)

Field	Year	Validity Coefficient						Size of Pooled Sample			
		GRE-V	GRE-Q	GRE-A	GRE-Adv	DR-UGPA	SR-UGPA	GRE-Apt	GRE-Adv	DR-UGPA	SR-UGPA
English	1974-75	.41	.24		.48	.22		190	122	144	
	1978	.21	.22	.14	.35	.21	.17	205	77	126	80
Education	1974-75	.18	.12		.54	.24		292	59	332	
	1978	.23	.21	.32	.08	.18	.19	276	28	202	251
History	1974-75	.31	.26		.21	.30		348	160	284	
	1978	.35	.33	.36	.36	.32	.38	95	50	72	80
Sociology	1974-75	.43	.30		.54	.55		287	43	146	
	1978	.64	.46	.33	.53	.28	.39	44	7	25	38
ALL VERBAL	1974-75	.32	.23		.38	.31		1117	384	906	
	1978	.27	.25	.27	.31	.22	.22	620	162	425	546
Chemistry	1974-75	.09	.31		.39	.31		389	219	419	
	1978	.19	.27	.30	.36	.27	.29	239	190	155	200
Mathematics	1974-75	.32	.23		.35	.30		154	34	32	
	1978	.21	.54	.19	.28	.44	.43	62	35	25	60
Computer Sci	1978*	.24	.23	.42	.13	.37	.22	104	13	61	91
Economics	1974-75	.09	.34		.45	.27		204	110	125	
	1978	.08	.21	.27	.24	.39	.26	124	76	71	106
ALL QUANT	1974-75	.14	.30		.40	.31		747	363	576	
	1978	.18	.28	.30	.31	.33	.29	529	314	312	457

Note: Data for 1978 are from the present study, and only scores on the restructured GRE Aptitude Test were included in the Aptitude Test analysis. Data for 1974-75 are from the Cooperative Validity Studies Project (Wilson, 1979, p. 21); no GRE analytical scores were generated for the earlier cohorts of first-time enrolled graduate students. The criterion in both studies is first-year graduate GPA.

*In analyses for 1974-75, Advanced Mathematics Test scores for computer science departments were included under "Mathematics." Note the very small Ns for the Advanced Computer Science and Sociology Test scores in the 1978 data.

Incremental Validity

The validity coefficients in Table S.1 indicate the correlation between each of the GRE Aptitude Test (and other) predictors and graduate GPA. Among other things, these validity coefficients confirm the a priori expectation of useful predictive validity for the new analytical ability measure, and they extend evidence regarding the usefulness of the verbal and quantitative ability measures and other predictors such as the GRE Advanced Test scores and the undergraduate GPA. However, it is also important to ask whether the information provided by the analytical score is sufficiently independent from that provided by verbal and quantitative scores to contribute incrementally to the prediction of first-year graduate GPA. This question was investigated through multiple regression analysis. Results were inconclusive, as suggested by the multiple correlation coefficients for various combinations of GRE Aptitude Test scores with first-year graduate GPA shown in Table S.2. (For detailed consideration of the results of the multiple regression analysis and evidence indicating elements of redundancy of information when the three Aptitude Test measures are treated as a battery, see Tables 4 and 5 and related discussion in the full report.)

- For example, in the fields classified as primarily verbal in emphasis, the best-weighted verbal and quantitative composite yielded multiple correlation coefficients that were similar to those for the best-weighted verbal and analytical composite; adding a third Aptitude Test score to the "most effective" pair of scores (i.e., either verbal and quantitative or verbal and analytical) does not appear to add much new information about academic performance potential (does not improve prediction very much).

- In the fields classified as primarily quantitative in emphasis, except for mathematics, coefficients for quantitative and analytical scores were higher than those for verbal and quantitative scores combined. This was especially evident for the computer science and economics samples. In the mathematics sample, essentially all the useful information for predicting first-year graduate GPA was accounted for by the quantitative score.

On balance, these findings suggest, as a working hypothesis for further investigation, that the analytical score may prove to be somewhat more useful as an additional predictor in the quantitative than in the verbal areas under consideration in this study. However, it is important to remember that, in general, questions regarding the predictive validity of variables used in admissions are recurring questions that call for frequently updated answers (through replication of studies) to keep abreast of changing circumstances--changes in curricular emphases, student input, grading standards, etc. Replication is especially critical when a new measure, such as the analytical ability measure, is introduced under a special set of conditions that has a potentially biasing effect on observed validity coefficients, such as the recommendation by the GRE Program that scores on the new measure not be used in assessment of applicants pending its formal validation. Replication based on samples of first-year students for whom scores on all three GRE Aptitude Test measures were freely considered in the admissions process is essential.

Other Findings

Additional multiple regression analyses provided evidence (a) that the self-reported undergraduate GPA (UGPA) constitutes a useful research surrogate for a departmentally reported UGPA, and that, consistent with previous research, a composite of UGPA and GRE Aptitude Test scores is a better predictor of graduate GPA than either set of measures alone (see Tables 6 and 7 and related discussion); and (b) that the GRE Advanced Test scores appear to be providing incrementally useful predictive information (see Tables 8 and 9 and related discussion).

Table S.2

Multiple Correlation of Various Combinations of Aptitude Test Scores with Graduate GPA, by Field

		Score combination				Largest zero-order coefficient
		V,Q (R)	V,A (R)	Q,A (R)	V,Q,A (R)	
English	205	.258	.210	.218	.263*	Q .218
Education	276	.257	.324	.324	.326	A .322
History	95	.405	.416	.387	.428	A .362
Sociology	44	.662	.637	.459	.682*	V .635
All Verbal	620	.307	.303	.290	.317	V .269
Chemistry	239	.289	.297	.326	.326	A .296
Mathematics	62	.535**	.222	.536*	.536*	Q .535
Computer Sci	104	.290	.425**	.432	.433**	A .425
Economics	124	.208	.287**	.293	.313**	A .269
All Quant	529	.293	.303**	.343	.344**	A .303

Note: Coefficients reflect relationships among departmentally standardized variables in samples pooled by field; data for 47 verbal departments and 53 quantitative departments were pooled.

* In this analysis, GRE-A variance is suppressed.

** In this analysis, GRE-V variance is suppressed.

(See Table 5 and related discussion of the suppression effect.)

Exploratory analyses of the predictive validity of the Aptitude Test measures in samples of minority students, and in samples grouped by sex, provided evidence suggesting that the predictive validity of the restructured GRE Aptitude Test is as great for minority as for nonminority students and is comparable for men and women (see Tables 10, 11, 12, 13, and 14 and related discussion).

Methodological Considerations

The subgroup analyses, as well as the basic analyses involving samples undifferentiated with respect to subgroup membership, were based on pooled samples across departments within fields. From a methodological point of view, the use of pooling procedures made it possible to generate estimates of validity by employing data from a relatively large number of departmental samples, no one of which was large enough to generate meaningful estimates of validity coefficients when considered independently. As indicated earlier, the coefficients analyzed in this study were estimated from intercorrelation matrices reflecting the relationships among pooled, departmentally standardized predictor and criterion variables for several very small departmental samples within the respective academic disciplines or fields.

For the individual departments involved in the study, these estimates are presumed to provide general guidance with respect to the validity of GRE Aptitude Test scores for predicting first-year graduate GPA. However, it is important to reiterate certain assumptions upon which the presumed translatability of the pooled findings into departmental-use contexts rests, namely:

a) that the variability in observed coefficients from several small departmental samples within a given discipline reflects primarily sampling fluctuation around common population values, an assumption for which some supportive evidence has been provided elsewhere (Wilson, 1979); and

b) that estimates of relationships based on pooled data from a number of small departmental samples within a given field provide reasonable (useful, practically significant) approximations to estimates that, theoretically, might be generated by pooling results of a similar number of replications involving successive samples of the same size within the respective departments (see Table 2, Figures 1, 2, and 3, and related discussion).

Further research bearing on these assumptions is needed. However, they have provided a useful operational rationale for generating information regarding the correlational validity of GRE scores by employing data from very small samples, none of which individually could support an interpretable validity study. It is important to keep in mind that the findings reported in the study are based on data for a particular set of departmental samples. The departments participating in the study are not necessarily representative of the population of departments within the respective fields. Accordingly, even granted the tenability of the pooling assumptions, the estimates of validity involved are not necessarily generalizable to other departments. The joint participation in GRE validity studies of a representative sample (or of samples representative of groups of departments classified according to a priori rules regarding similarity) would provide data that would be useful for the purpose of testing the validity of pooling assumptions, per se, and findings that are generalizable to clearly defined populations.

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Section I: Background of the Study

Following several years of research and development activity, supported by the Graduate Record Examinations (GRE) Board, the restructured GRE Aptitude Test was introduced in October 1977. As described in detail by Miller and Wild (1979), the restructuring process involved the development of shortened but comparable versions of the familiar measures of verbal and quantitative abilities and the introduction of a measure of analytical ability.

Items making up the analytical ability section that was introduced in 1977 are described as measuring such components of analytical ability as drawing conclusions from a complex series of statements, using a sequential procedure to eliminate incorrect choices in order to reach a conclusion, making inferences from statements expressing relationships among abstract entities (such as nonverbal or nonquantitative symbols), etc. Successful performance on the analytical ability measure is thought to be independent of formal training in logic or methods of analysis (ETS, 1977). The aim of the GRE Board in encouraging and supporting the introduction of a third ability measure was to broaden the widely used GRE Aptitude Test and enable students to demonstrate a wider array of academic talent than that tapped by the traditional verbal and quantitative ability measures.

According to the 1977-78 Guide to the Use of the Graduate Record Examinations the analytical score correlates about .70 with both verbal and quantitative scores. This is somewhat higher than the correlation between verbal and quantitative scores (in the .50 to .60 range, depending upon population), but lower than would be expected (e.g., .90 +) for two tests measuring the same underlying abilities. Hence it was believed that the new measure should supplement the traditional verbal and quantitative measures.

On the strength of its relationship with verbal and quantitative scores, which have known utility for predicting performance in graduate study (Willingham, 1974; Wilson, 1979), the analytical score was expected to have utility for predicting typical criteria of performance in graduate study. The expectation of utility for prediction in the analytical score, per se, was further buttressed by evidence of its relationship to self-reported undergraduate grade-point average (UGPA). As reported by Miller and Wild (1979), evidence gathered during the development of the analytical measure indicated that correlations between analytical scores and candidates' self-reported UGPA paralleled those for verbal and quantitative scores.

Despite the presumption of utility inherent in the foregoing lines of reasoning and evidence, when the restructured GRE test was introduced, graduate schools were advised not to consider the analytical scores in appraising the academic qualifications of applicants for admission pending the establishment of empirical evidence regarding the relationship between the score and performance in graduate study.

Objectives of the Study

The study reported herein, conducted with the encouragement and support of the GRE Board, was initiated early in 1979 for the purpose of obtaining empirical evidence regarding the predictive validity of the restructured GRE Aptitude Test. Questions regarding the contribution of the analytical measure were of special concern, of course, but it was also considered important to obtain evidence of the correlational validity of scores on the restructured verbal and quantitative sections.

Though the need for empirical evidence of predictive validity for the analytical score, per se, was basic to the study, other questions about the role of this measure were also of interest. For example:

- Does the analytical score, which correlates in the .70 range with verbal and quantitative scores, tap an ability component that is sufficiently independent of verbal and quantitative ability to improve the overall validity and utility of the GRE Aptitude Test?

- Does the information provided by the analytical score supplement that provided by the verbal score and/or the quantitative score? For example, will an Aptitude Test composite that includes an analytical ability score prove to be more useful for prediction of typical graduate school performance criteria than a composite that includes only verbal and quantitative ability scores?

- If so, does the supplementary contribution of the analytial score appear to be general (leading, for example, to incremental validity without regard to field) or field specific (contributing added predictive information only in certain fields)?

In January 1979 graduate schools receiving a large number of GRE score reports were invited to participate in a study designed to provide evidence bearing on these general questions. The results reported herein are based on analyses of data for 100 small departmental samples (36 graduate schools) from the fields of English, education, history, economics, chemistry, mathematics, computer science, and economics. Following the analytical rationale and assumptions described herein, assessments of validity are based on samples of departmental data pooled by field.

The results provide preliminary evidence of the validity of the restructured GRE Aptitude Test (and selected other predictors) for predicting first-year graduate grade-point average in samples of first-time graduate students entering in fall 1978, in subgroups defined in terms of sex, and in samples of self-identified minority students. The results reported augment a growing body of research evidence regarding the validity of GRE tests and measures of undergraduate achievement (such as undergraduate GPA) for forecasting first-year performance in graduate school settings.

Section II: Sample and Basic Data

In the absence of a firm rationale for identifying fields or disciplines for which the type of ability represented by the analytical score might be especially relevant or irrelevant, choice of fields for the validity study was based on a desire to obtain a representative array with respect to traditional verbal versus quantitative emphases. Accordingly, a decision was made to focus the analysis primarily on the following fields: English, education, history, and sociology (thought of as primarily verbal), and chemistry, mathematics, computer science, and economics (thought of as primarily quantitative).

Based on experience gained during the Cooperative Validity Studies Project (Wilson, 1979), it was considered important to have departmental samples that were homogeneous with respect to educational status at point of entry. It was decided, accordingly, that data would be sought only for students who entered a department as first-time graduate students.

Because of the urgent need for empirical evidence bearing on the predictive validity of the analytical score in graduate-school settings, it was decided to base the study on data for only one entering cohort of first-time enrolled students, namely, that entering in fall 1978, rather than delay data collection until criterion data for two cohorts could be obtained. It was recognized that this decision would result in a rather severe restriction of the size of samples available for individual departments. Accordingly, 10 first-time graduate students with necessary data (i.e., scores on the restructured Aptitude Test and a first-year graduate GPA) was tentatively set as the minimum N expected for participation.

In January 1979 a letter of invitation to participate in the study was sent over the signature of the GRE Board chairman to graduate deans representing about 100 schools receiving the largest number of GRE score reports annually. An overview of the definitions, procedures, and proposed activities of the study was enclosed along with a Participation Reply Form.*

A total of 50 graduate schools expressed an interest in the study and some 250 departments were designated as prospective participants. They were distributed rather evenly over the eight basic fields. Following initiation of data-collection procedures, it became apparent that most of the designated departments could not meet the suggested minimum sample size of 10 cases (with scores on the restructured GRE Aptitude Test and a graduate GPA); in many departments fewer than five cases with these data were available. Accordingly, a decision was made to include in the basic analysis all departments with at least five first-time enrolled full-time students who had scores on the restructured GRE Aptitude Test and a first-year graduate GPA.**

After all screening criteria had been applied, 100 departmental samples from the eight basic study fields were identified. These departments were from the 36 graduate schools listed in Table 1.

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*Copies of the invitational letter and selected accompanying materials are provided in Appendix A. Two different data-collection procedures were employed, primarily to provide a basis for assessing the relative utility of alternative approaches to facilitating the validity process by employing the GRE history file to generate GRE scores and other relevant data on candidates rather than relying on participants to provide all needed study data.

**Because of the potentially confounding effect of including foreign students who were not natively fluent in English, a decision was made to exclude such students. This additional constraint eliminated several departments.

Table 1

Graduate Schools Participating in the Restructured GRE Aptitude Test Validity Study: Data for the 1978-79 Academic Year

University of Oklahoma	San Diego State University
Texas Technological University	Colorado State University
University of Iowa	University of Massachusetts
Louisiana State University	University of Rochester
Iowa State University	University of Pittsburgh
Texas A&M University	University of Pennsylvania
University of Virginia	Syracuse University
University of North Carolina	SUNY at Stony Brook
University of Maryland	SUNY at Albany
University of Florida	Wayne State University
University of Central Florida	University of Wisconsin
Florida State University	University of Tennessee
University of Washington	University of Notre Dame
University of Southern California	University of Cincinnatti
University of Colorado (Boulder)	Ohio State University
University of San Diego	Northwestern University
University of California (Davis)	Loyola University of Chicago
Washington State University	Jackson State University

Additional Predictors

In addition to scores on the restructured Aptitude Test and first-year graduate GPA, other relevant predictor variables were selected for analysis, as follows:

1) departmentally reported undergraduate GPA (DR-UGPA) if supplied by a participating department;

2) self-reported undergraduate GPA (SR-UGPA) in the undergraduate major field, if reported by a candidate when registering for the GRE Aptitude Test; and

3) GRE Advanced Test score as appropriate to field (from the GRE history file if available for a candidate).

The minimum-of-five-cases rule, applied for GRE Aptitude Test scores and graduate GPA, was also applied in the decision to include each of these additional predictors as part of a particular departmental data set. Table 2 shows the number of departmental samples from the eight basic study fields having data for at least five students who earned a first-year graduate GPA and who had (a) scores on the restructured GRE Aptitude Test, (b) a self-reported UGPA in the major field, (c) a departmentally reported UGPA, and (d) a GRE Advanced Test score appropriate to the field. Also shown is the mean size of the departmental samples.

It may be seen that scores on the GRE Aptitude Test and graduate GPA were available for a total of 100 samples, 47 from departments in the fields characterized as primarily verbal and 53 from fields characterized as primarily quantitative. The self-reported UGPA (major field), or SR-UGPA, was available for five or more students in 91 of the 100 samples, but a departmentally reported UGPA (DR-UGPA) was available in only 62 samples; only 54 samples had at least five students with an appropriate GRE Advanced Test score.

On the average, departmental samples in analyses involving only the restructured GRE Aptitude Test included about 13 cases in the primarily verbal fields and 10 cases in the primarily quantitative fields. Variation in mean departmental sample size by field clearly was not great--the mean for education was elevated by the inclusion of one or two relatively large departmental samples. Data not reported in the table indicate that 59 of the 100 samples involved in the basic GRE Aptitude Test analysis had Ns in the 5 - 9 range, and 91 out of 100 had fewer than 20 cases.

Table 2

Number and Mean Size of Departmental Samples with Data for Analyses Involving Designated Predictor Variables

Field	Analyses Involving							
	GRE V,Q,A only		GRE V,Q,A & SR-UGPA		GRE V,Q,A & DR-UGPA		GRE V,Q,A & GRE Adv	
	No. depts.*	Mean N	No. depts.	Mean N	No. depts.	Mean N	No. depts.	Mean N
English	(18)	11.4	(16)	11.1	(12)	10.5	(9)	8.6
Education	(12)	23.0	(11)	22.8	(8)	25.2	(2)	14.0
History	(10)	9.5	(8)	10.0	(7)	10.3	(6)	8.3
Sociology	(7)	6.3	(6)	6.3	(4)	6.2	(1)	7.0
All Verbal	(47)	13.2	(41)	13.3	(31)	13.7	(18)	9.0
Chemistry	(21)	11.4	(20)	10.0	(13)	11.9	(21)	9.0
Mathematics	(7)	8.9	(7)	8.6	(3)	8.3	(4)	8.8
Computer Science	(11)	9.5	(10)	9.1	(7)	8.7	(2)	6.5
Economics	(14)	8.8	(13)	8.2	(8)	8.9	(9)	8.4
All Quantitative	(53)	10.0	(50)	9.1	(31)	10.1	(36)	8.7

*This is the number of departments with at least five first-time graduate students having a first-year graduate GPA and restructured Aptitude Test scores; other parenthesized entries indicate the number of departments with at least five students having a graduate GPA and observations on the predictor designated. Thus, for example, a total of 18 English departments met the minimum-of-five-cases-with-data rule with respect to the restructured Aptitude Test, 16 did so with respect to self-reported UGPA, 12 with respect to departmentally reported UGPA, but only 9 with respect to the GRE Advanced Test score.

Section III. Analytical Methods

Given the very small samples available for analysis, the results of analyses for a given department cannot provide estimates of relationships among the variables that are sufficiently reliable to permit inferences regarding the predictive validity of the variables under consideration in that departmental context. Generally illustrative of this point is evidence, summarized in Figure 1, of the degree of observed variability in distributions of zero-order correlation coefficients reflecting the relationship between the analytical ability score and graduate GPA as a function of sample size in the 100 departmental samples available for analysis. (Similar patterns obtain, of course, in distributions of observed coefficients for the verbal score, the quantitative score, and other predictors in these samples.) To proceed with an analysis designed to yield interpretable information regarding within-department predictor-criterion relationships in these circumstances, data from several departments must be pooled.

Pooling Rationale

Unfortunately from the point of view of assessing the predictive validity of scores on a standardized admission test, the criterion variable under consideration, namely, first-year graduate GPA, is context-specific in both metric and meaning. Even when grade-point averages are computed in a comparable way (e.g., on a scale such that A = 4, B = 3, C = 2, etc.) in several different departments, comparisons based on mean GPA do not permit inferences regarding average performance differentials for students in the departments involved.

Useful perspective on this line of reasoning is provided in Figure 2, which reflects the relationship between departmental GPA means and mean GRE Aptitude Test scores for 76 of the departmental samples available for the present study--that is those with GPA scales that assign 4 points to an A, 3 to a B, 2 to a C, etc. It is apparent that mean GPA does not vary in a systematic way with mean GRE Aptitude Test scores across the departments. In the 35 verbal departments, for example:

- Grade-point averages of 3.8 or higher are registered by departments differing by some 300 points with regard to mean GRE verbal score; the highest mean GPA is associated with the lowest verbal mean score.

- Departments with similar GPA means differ widely in mean verbal scores; the lowest mean GPA (less than 3.1) and one of the highest GPA means (over 3.8) are associated with two English departments, both of which have mean verbal scores in the 576-600 range.

In the circumstances, lacking a context-free estimate of performance for each individual, the only useful comparisons for purposes of validation become those involving relative standing within departmental samples--for example, z-scaled transformations of the GPA criterion as well as the standard predictor variables. Given such transformations, data for several small departmental samples can be pooled, and analyses can be based on the larger pooled samples. These analyses will yield more reliable estimates of within-group (within-department) relationships among the variables under consideration.

Given the marked variability in GRE Aptitude Test score means among the departmental samples within each field (see Figure 3), and the well-established expectation of positive covariation between GRE scores and performance within departments, pooling procedures that require us to ignore marked among-department differences in GRE Aptitude Test scores clearly may be expected to yield attenuated estimates of validity for the predictors under consideration. However, the estimates involved are assumed to be realistic from the point of view of individual graduate departments.

Coeff.	Sample size (verbal fields)*						Sample size (quant fields)*						Sample size (all fields)					
	5-9	10-19	20-29	30-39	40+	Tot Verbal	5-9	10-19	20-29	30-39	40+	Tot Quant	5-9	10-19	20-29	30-39	40+	Tot V & Q
.9	1					(1)						(-)	1					(1)
.8	1					(1)	3					(3)	4					(4)
.7	2	3				(5)	6	1				(7)	8	4				(12)
.6	1	1		1		(3)	-	2				(2)	1	3		1		(5)
.5	2	-		-		(2)	4	2				(6)	6	2		-		(8)
.4	1	2	2	-	1	(6)	3	3				(6)	4	5	2	-	1	(12)
.3	3	-	-	-	-	(3)	4	3				(7)	7	3	-	-	-	(10)
.2	2	-	-	1	1	(4)	3	1	1			(5)	5	1	1	1	1	(9)
.1	1	1	1	-		(3)	2	2				(4)	3	3	1	-		(7)
.0	2	1		1		(4)	2	2				(4)	4	3		1		(8)
-.0	1	1				(2)	-	2				(2)	1	3				(4)
-.1	5	-				(5)	1	3				(4)	6	3				(9)
-.2	2	1				(3)	1					(1)	3	1				(4)
-.3	1	-				(1)	-					(-)	1	-				(1)
-.4	1	-				(1)	2					(2)	3	-				(3)
-.5	-	1				(1)						(-)	-	1				(1)
-.6	-					(-)						(-)	-					(-)
-.7	2					(2)						(-)	2					(2)
-.8						(-)						(-)						(-)
-.9						(-)						(-)						(-)
No. depts.	28	11	3	3	2	(47)	31	21	1	(-)	(-)	(53)	59	32	4	3	2	(100)

*Verbal (English, education, history, sociology); quantitative (chemistry, mathematics, computer science, economics); see Table 2 for number of departments from each field.

Figure 1. Variability in observed predictor-criterion (GRE-A, Grad GPA) correlation coefficients for 47 primarily verbal and 53 primarily quantitative departments as a function of sample size.

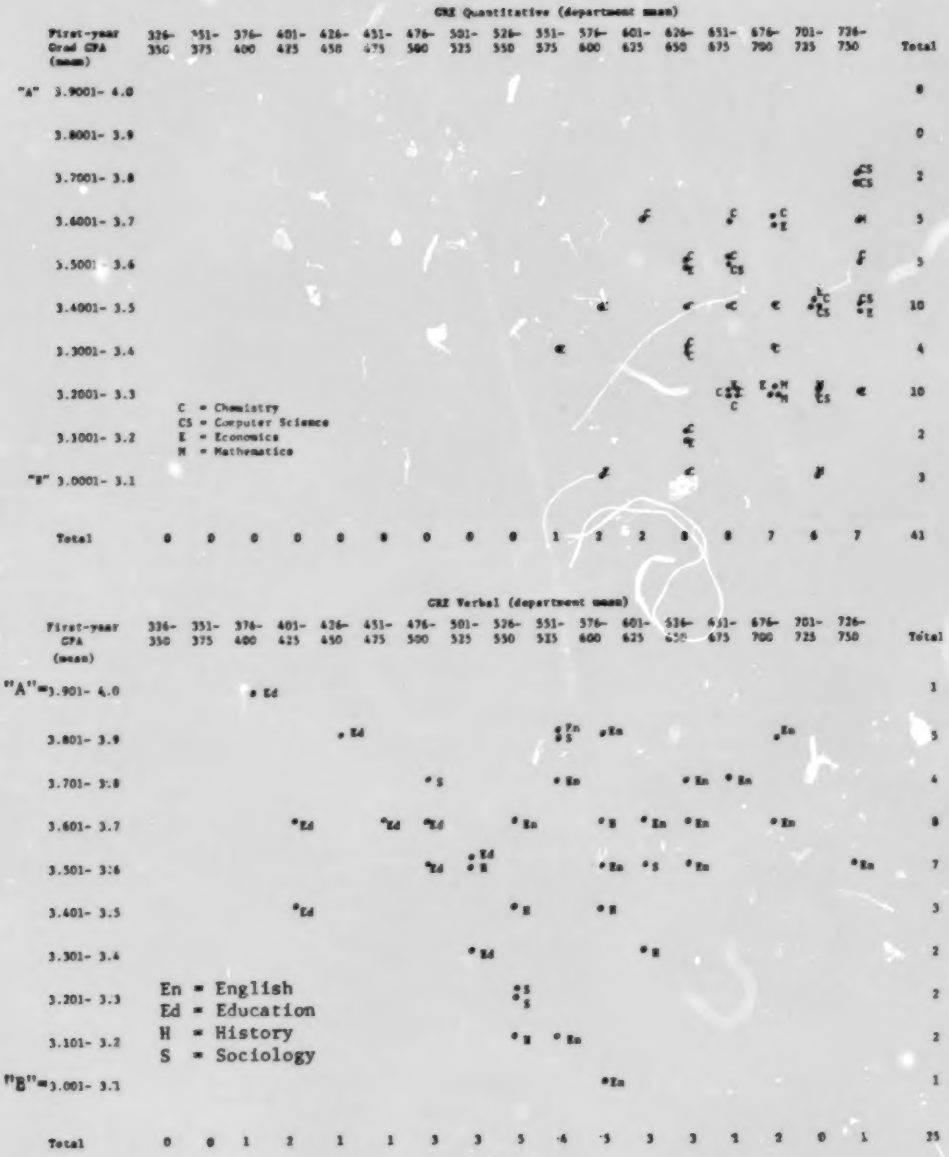

Figure 2. Mean GRE Aptitude Test score (GRE-V or GRE-Q as appropriate to a field) in relation to mean Year 1 graduate GPA for 35 departmental samples from primarily verbal fields and 41 samples from primarily quantitative fields.

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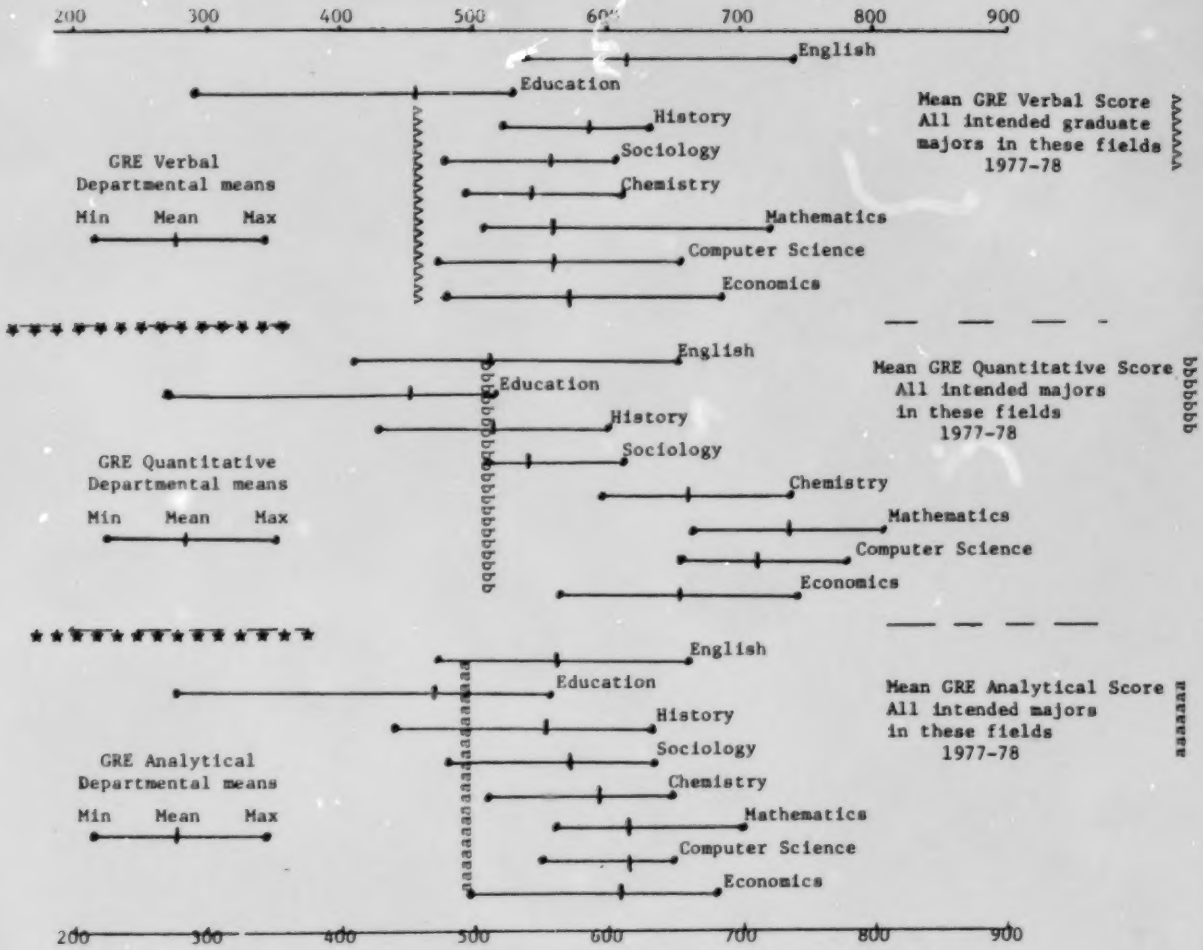

Figure 3. Range of mean scores of departmental samples on the restructured GRE Aptitude Test.

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Assumptions and Limitations

Assuming that the predictor and criterion data for each of the 100 departmental samples in the basic study have been converted to a common metric, with mean = zero and sigma (standard deviation) = unity [$(X - \bar{X})/\text{sigma}$], within departments, a decision must be made regarding pooling criteria: Which samples will be grouped for purposes of pooling? At the graduate level, validity studies have tended to focus on the department as the basic context for analysis and discipline or field of study as the primary taxonomic variable for purposes of classifying departments. Thus, pooling data for departments according to discipline is consistent with the functional or disciplinary structure of the graduate school.

With field, or discipline, as the primary criterion for grouping departments whose data are to be pooled, the use of pooled within-group (within-department) data to arrive at estimates of validity that are meaningful for individual departments rests on certain assumptions. One assumption underlying this approach is that the variability in observed coefficients in very small samples from several departments within the same field reflects primarily sampling fluctuation around a common population value.

Given standardized data sets (predictor/criterion observations) for comparable samples (e.g., first-time enrolled graduate students) from, say, 18 English departments (each very small), a working corollary of the foregoing assumption is that the estimate of relationships based on the pooled within-department data provides a reasonable (useful, practically significant) approximation to an estimate that, theoretically, might be generated by pooling results of a comparable number of replications involving successive samples of comparable size within each department--a remote possibility in practice.

Evidence generally supportive of such assumptions is provided by the results of a GRE validity study (Wilson, 1979) that indicated that observed regression weights for verbal and quantitative scores and undergraduate GPA did not tend to vary significantly from weights estimated from pooled within-group departmental data;* the individual departmental samples involved, though small by usual validity-study standards, were, functionally, considerably larger than the samples available for the present study. Because of the extremely small size of the samples available for the present study, and the correspondingly very substantial sampling error for each observed coefficient, a direct test of the common weights hypothesis was not undertaken.

All the analyses in this study that are concerned with estimating relationships of predictors or combinations of predictors with performance are based on pooled, departmentally standardized data. Data have been pooled by field, and two clusters of fields have been designated, on the basis of judgment, as being either primarily verbal (English, education, history, and sociology) or primarily quantitative (chemistry, mathematics, computer science, and economics). The arbitrary nature of this classification is recognized.

In considering results of the pooled-data analyses, it is important to note that the participating departments cannot be assumed to be representative of the population of departments in the respective fields. If, for each discipline under consideration here, the departments involved were a random or stratified random sample, stronger inferences could be made regarding field differences in the observed patterns of relationships for a common set of predictor-criterion variables. In our sample of voluntary participants, we find considerable unevenness across fields in the number of departments (ranging from 7 in sociology and mathematics, for example, to 21 in chemistry).

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*Evidence of a very substantial amount of validity generalization across 726 law-school validity studies has been reported by Linn, Harnisch, and Dunbar (1981).

Finally, to make a point that will be reiterated in this report, because of the special circumstances involved in the introduction of the GRE analytical ability measure (i.e., reported scores were to be ignored in screening applicants during the admissions period covered by this study), inferences regarding the comparative and/or incremental validity of this ability measure with respect to the traditional verbal and quantitative ability scores should be thought of as quite tentative in nature. Verbal and quantitative scores suffer in this particular within-group correlational competition from attenuation through restriction due to direct selection whereas any attenuation for analytical scores is the result of restriction due to indirect selection only.

Procedures

Intercorrelation matrices, means, and standard deviations of variables (as available) in their normal (nonstandardized) metric were first computed for each of the available departmental data sets. Within each of the eight fields (and the two broad classifications of fields--i.e., verbal or quantitative), weighted means of the elements of the respective departmental intercorrelation matrices were then computed to construct several field matrices reflecting interrelationships among pooled departmentally standardized variables.

It is important to note in this connection that a pooled field matrix whose elements are weighted means of the corresponding elements of the several departmental matrices is identical to the field matrix that would be determined by computing intercorrelations using variables all of which had been subjected to a z-scale transformation (mean = zero and standard deviation = unity within each department) prior to pooling.

Each of the pooled field matrices involved a different combination of departments and variables, depending upon data availability, as follows:

I. an Aptitude Test matrix (GRE-V, GRE-Q, GRE-A, and graduate GPA) based on data for all samples;

II. a self-reported UGPA or SR-UGPA matrix (as for I, plus SR-UGPA) based on data for all samples in which at least five (but not necessarily all) students had a SR-UGPA;

IIA. a departmentally reported UGPA or DR-UGPA matrix based on data for all samples in which at least five (but not necessarily all) students had a DR-UGPA and a SR-UGPA.

III. An Advanced Test matrix (as for I, plus GRE Advanced Test score) based on data for all samples in which at least five (but not necessarily all) students presented a GRE Advanced Test score.

These field matrices provided estimates of the zero-order validity coefficients for the respective predictors, based on the total number of individuals with data on a predictor, and were also employed for multivariate analyses as follows:

- Questions regarding the regression of graduate GPA on the restructured GRE Aptitude Test battery, especially questions regarding the role of the analytical ability score relative to the traditional verbal and quantitative scores, were addressed most directly and basically through multiple regression analyses using the Aptitude Test matrix.

- Questions regarding the contribution of the undergraduate grade-point average were addressed in multiple regression analyses using the SR-UGPA matrix (which reflected pooled data for a total of 91 of the 100 departments) rather than the DR-UGPA matrix (reflecting pooled data for only 62 departments); results of comparative

analyses based on data for 58 departments with both DR-UGPA and SR-UGPA suggested that, for research purposes, the more widely available self-reported UGPA constituted a credible surrogate for the more-or-less official UGPA index (as reported by a department), which had only limited availability.

- The Advanced Test matrix was employed in multiple regression analyses designed to assess the contribution of GRE Advanced Test scores when used in conjunction with the restructured GRE Aptitude Test battery; this matrix reflected pooled data for only slightly more than one-half of the departments in the study (54 of 100).

Subgroup Analyses

Consideration of questions regarding the predictive validity of the restructured Aptitude Test for subgroups defined in terms of sex or for minority students was not a part of the basic design of the present study. However, the importance of obtaining empirical evidence regarding the patterns of validity for predictors in such subgroups is evident. Accordingly, information regarding the comparative validity of the restructured Aptitude Test (for men and women and for minority and nonminority students) was sought in a set of exploratory analyses involving pooled departmentally standardized (z-scaled) verbal, quantitative, and analytical scores, and SR-UGPA and graduate GPA, respectively.*

In these analyses, each variable was z-scaled within each department using the estimates of the mean and standard deviation for each within-department total sample. Following this scale transformation, the z-scores for individuals in the respective subgroups were pooled for analysis by field. These analyses provide insight into (a) the average deviation of the means for subgroups on the predictor and criterion variables under consideration from their respective departmental means, in departmental standard deviation units, and (b) the correlation of z-scores on the predictors with z-scores on the graduate GPA criterion in each of the subgroups.

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*Classification of students according to sex and "minority" vs "nonminority" status was based on information in the GRE history file. Detailed consideration of the classification process is provided in the subsequent section of this report that treats findings for subgroups.

Section IV: Basic Study Findings

Presentation and discussion of findings in this section follows the general sequence of analysis outlined in the previous section, namely:

1) estimation of validity coefficients for the restructured Aptitude Test and selected additional predictors with respect to graduate GPA;

2) analysis of the regression of graduate GPA on the restructured GRE Aptitude Test;

3) analysis of the role of the undergraduate grade-point average when added to the restructured Aptitude Test;

4) analysis of the contribution of the GRE Advanced Test score to prediction when added to the Aptitude Test battery; and

5) analysis of the predictive validity of the restructured Aptitude Test for subgroups defined in terms of sex and self-reported ethnic status (minority vs. nonminority).

Estimates of Validity for the Predictors*

Table 3 provides two sets of estimates of validity coefficients based on pooled departmentally standardized variables, namely, (a) estimates derived in the present study using data for first-time students entering in 1978 who presented scores on the restructured GRE Aptitude Test and (b) estimates from the Cooperative Validity Studies Project (Wilson, 1979) for first-time students entering in 1974 and 1975, combined, who presented scores on the traditional GRE Aptitude Test. Also shown for each coefficient reported is the number of cases on which it is based.

Regarding the analytical ability measure, the following observations are relevant:

- In three of the four fields designated as quantitative (all but mathematics), validity coefficients for the analytical score are slightly higher than those for the quantitative score and coefficients for both quantitative and analytical scores are higher than those for the verbal score.

- In the so-called verbal fields, the observed pattern of coefficients for the three scores is not a consistent one; in the comparatively large, pooled education sample the analytical score comes out ahead in the correlational competition with verbal and quantitative scores and in history the coefficient for the analytical score parallels that for the verbal score. The verbal score is dominant (and atypically high) in the sociology sample (N = 44).

- If attention is focussed on findings for the two broad field classifications, it is evident that the coefficient for the analytical score tends to parallel those for the verbal and quantitative scores in the all verbal sample and that for the quantitative score in the all quantitative sample.

With regard to GRE Advanced Test scores, the observed coefficients from the current study and those from the earlier study suggest the importance of including in an admissions appraisal a measure that reflects achievement in a content area.

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*The findings summarized in this section were included in a preliminary report submitted to participants in the study. A copy of that report is attached as Appendix B.

Table 3

Validity Coefficients Estimated Using Departmentally Standardized Variables in Pooled Departmental Samples, by Field: 1974 and 1975 and 1978 Samples

(Criterion is First-Year Graduate GPA)

Field	Year	Validity Coefficient						Size of Pooled Sample			
		GRE-V	GRE-Q	GRE-A	GRE-Adv	DR-UGPA	SR-UGPA	GRE-Apt	GRE-Adv	DR-UGPA	SR-UGPA
English	1974-75	.41	.24		.48	.22		190	122	144	
	1978	.21	.22	.14	.35	.21	.17	205	77	126	80
Education	1974-75	.18	.12		.54	.24		292	59	332	
	1978	.23	.21	.32	.08	.18	.19	276	28	202	251
History	1974-75	.31	.26		.21	.30		348	160	284	
	1978	.35	.33	.36	.36	.32	.38	95	50	72	80
Sociology	1974-75	.43	.30		.54	.55		287	43	146	
	1978	.64	.46	.33	.53	.28	.39	44	7	25	38
ALL VERBAL	1974-75	.32	.23		.38	.31		1117	384	906	
	1978	.27	.25	.27	.31	.22	.22	620	162	425	546
Chemistry	1974-75	.09	.31		.39	.31		389	219	419	
	1978	.19	.27	.30	.36	.27	.29	239	190	155	200
Mathematics	1974-75	.32	.23		.35	.30		154	34	32	
	1978	.21	.54	.19	.28	.44	.43	62	35	25	60
Computer Sci	1978*	.24	.23	.42	.13	.37	.22	104	13	61	91
Economics	1974-75	.09	.34		.45	.27		204	110	125	
	1978	.08	.21	.27	.24	.39	.26	124	76	71	106
ALL QUANT	1974-75	.14	.30		.40	.31		747	363	576	
	1978	.18	.28	.30	.31	.33	.29	529	314	312	457

Note: Data for 1978 are from the present study, and only scores on the restructured GRE Aptitude Test were included in the Aptitude Test analysis. Data for 1974-75 are from the Cooperative Validity Studies Project (Wilson, 1979, p. 21); no GRE analytical scores were generated for the earlier cohorts of first-time enrolled graduate students. The criterion in both studies is first-year graduate GPA.

*In analyses for 1974-75, Advanced Mathematics Test scores for computer science departments were included under "Mathematics." Note the very small Ns for the Advanced Computer Science and Sociology Test scores in the 1978 data.

However, the fact that these and other estimates of the validity of Advanced Test scores are almost always based on a selected subgroup of individuals who present GRE Aptitude Test scores introduces elements of interpretive ambiguity in comparative assessment.

Finally, validity coefficients for the self-reported UGPA parallel those for the departmentally reported UGPA, for the most part, suggesting that this self-report index may be a satisfactory research surrogate for the departmentally reported index.

In all the foregoing, attention has been focused on the validity of each of the restructured Aptitude Test scores and selected additional predictors. In the sections that follow, attention is focussed primarily on questions regarding the relative contribution of scores on the restructured Aptitude Test to prediction of graduate GPA.

Predictive Validity of the Restructured Aptitude Test: A Multivariate Assessment

Table 4 provides evidence regarding the correlation of the verbal, quantitative, and analytical scores, separately and in best-weighted and equally weighted composites, with first-year graduate GPA.

As previously noted, during the period in which the students in this study were applicants for admission, schools and departments were advised by the GRE Program not to consider the analytical score pending collection of empirical data bearing on its predictive validity. Assuming this advice was followed, the coefficients for verbal and quantitative scores would be attentuated due to direct selection, whereas the coefficient for the analytical score would be affected by indirect selection only.

This set of circumstances should be kept in mind in evaluating the findings. The comments that follow regarding, for example, the relative magnitudes of zero-order and/or regression coefficients for the three Aptitude Test scores should be thought of primarily as descriptive of trends in the particular set of data at hand and suggestive of interpretive rationales.

With respect to zero-order coefficients:

- The analytical score, like the verbal and quantitative scores, is positively associated with graduate GPA in every analysis.

- In three of the four quantitative fields (all but mathematics), the zero-order coefficient for the analytical score is higher than that for either the verbal or the quantitative score, especially so in computer science; in the comparatively small mathematics sample, the quantitative score is dominant and the coefficient ($r = .535$) is atypically high.

- No particular pattern is evident in the several verbal fields--in the small sociology sample, the verbal score is dominant and the coefficient ($r = .635$) is atypically high; in the English sample, the verbal score is noticeably less closely associated with graduate GPA than either the verbal or quantitative score, but it is the best single predictor in education; and in history, the coefficients for the three scores are quite similar.

- In the two larger pooled samples (i.e., the all verbal and all quantitative samples), the pattern for the all quantitative sample is one of higher coefficients for the quantitative and analytical scores than for the verbal score while, for the all verbal sample,the verbal and analytical scores tend to have slightly higher validity coefficients than the quantitative score, but differences in magnitude are very slight.

Table 4

Correlation of Scores on the Restructured GRE Aptitude Test, Separately and in Best-Weighted and Equally Weighted Composites, with First-Year Graduate GPA in Pooled Departmental Samples, by Field

FIELD	No. of depts.	No. of cases	Simple correlation GRE-V	GRE-Q	GRE-A	Optimal weight * GRE-V	GRE-Q	GRE-A	V + Q + A Optimal wts. R	Equal wts. r
VERBAL FIELDS										
ENGLISH	(18)	205	.208	.218	.136	.177	.199	-.080	.263	(.229)
EDUCATION	(12)	276	.226	.209	.322	.040	.042	.274	.326	(.304)
HISTORY	(10)	95	.352	.326	.362	.212	.128	.185	.428	(.425)
SOCIOLOGY	(7)	44 **	.635	.455	.326	.626	.312	-.228	.682	(.579)
[ALL VERBAL]	(47)	620	.269	.247	.267	.157	.118	.110	.317	(.317)
QUANTITATIVE FIELDS										
CHEMISTRY	(21)	239	.188	.273	.296	.015	.158	.203	.326	(.311)
MATHEMATICS	(7)	62 **	.209	.535	.192	.001	.544	-.022	.536	(.385)
COMPUTER SCIENCE	(11)	104	.245	.232	.425	-.028	.089	.408	.433	(.380)
ECONOMICS	(14)	124	.080	.206	.269	-.138	.134	.303	.313	(.237)
[ALL QUANTITATIVE]	(53)	529	.176	.280	.303	-.026	.184	.236	.344	(.316)

Note: Coefficients reflect relationships among departmentally standardized variables in samples pooled by field; data for 47 verbal and 53 quantitative departments were pooled, by field. Elements of the respective pooled correlation matrices were weighted means of the corresponding elements of the individual departmental matrices.

*Standard partial regression coefficients or beta weights (defined by least-squares fit to sample data); note negative beta weights for either GRE-V or GRE-A in several analyses even though all validity coefficients are positive, indicating suppression effects (see p. 21 ff. for detailed discussion).

**It is important to note that in these two samples, which have the smallest Ns, we find the highest pair of zero-order coefficients and the greatest discrepancy between the multiple correlation coefficient (involving optimal weights) and the validity coefficients for equally weighted composites of V, Q, and A, which are unbiased estimates of the population values for such composites.

Also shown in Table 4 for each sample are (a) the coefficient of multiple correlation for a weighted composite of verbal, quantitative and analytical scores versus graduate GPA, (b) the standard partial regression (optimal) weights defined by least squares with analysis for each sample, and (c) a coefficient reflecting the correlation with graduate GPA of an equally weighted composite of the three scores (which provides an unbiased estimate of the population value for such a composite).

One of the more interesting and potentially important messages being transmitted by these data would seem to be that, in certain of the analyses, each of the three Aptitude Test scores appears to contribute some unique information regarding performance potential as reflected in graduate GPA; in others, two of the Aptitude Test scores seem to be carrying most of the load; in still others, a single Aptitude Test score seems to be dominant and perhaps sufficient. At the same time, in several of the analyses, an equally weighted composite of the three scores yields a coefficient whose value approximates that of the (unshrunken) multiple correlation coefficient.

With these themes in mind, let's take a closer look at the results of multivariate analysis.

In the primarily quantitative fields, it appears that the contribution to prediction being made by the verbal score is slight and/or indirect (i.e., through suppression)* when it is combined with the analytical and quantitative scores except in mathematics, for which the quantitative score is dominant (and in this sample, as effective for prediction as the entire Aptitude Test battery). Generally speaking, the quantitative and analytical scores appear to be operating as a team in the quantitative fields (although in computer science the analytical score is carrying most of the load).

In the verbal fields, the patterning of relative weights does not suggest a comparable, relatively consistent teaming of the analytical score with the theoretically dominant verbal score. The contribution of the analytical score is indirect (i.e., through suppression) in two analyses (English and sociology); in education, it actually carries most of the load, while in the history and all verbal analyses, the three Aptitude Test scores appear to be sharing the predictive load equally.

It is of interest to note, however, that the weight distribution dictated by best-fit regression, as compared with the relative value of the observed zero-order validity coefficients, tends to reflect a shifting (albeit slight) of the load from the analytical to the verbal score. For example, in the history sample, the analytical score has a slightly higher zero-order coefficient than the verbal score, but the opposite is true of the regression weights; similarly, in the all verbal analysis, the quantitative score (with a lower zero-order coefficient than the analytical score) comes out with a slightly higher share of the total load as reflected in the regression coefficients.

Thus, to summarize briefly from the data in Table 4, in the several quantitative-field samples, the analytical and quantitative scores appear to be carrying most of the load; the pattern in the several verbal-field samples is not similarly consistent--that is, a consistent pairing of the analytical score with the theoretically dominant verbal score does not appear.

Further evidence bearing on these patterns is provided in Table 5.

In the several quantitative fields, the quantitative and analytical score composite yields a higher multiple correlation with graduate GPA than the verbal and quantitative composite, and the multiple correlation for the quantitative and analytical composite tends to be about as great as that for all three scores.

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*See the next subsection for a detailed examination of the suppression phenomenon.

Table 5

Multiple Correlation of Various Combinations of Aptitude Test Scores with Graduate GPA, by Field

		Score combination				Largest zero-order coefficient
		V,Q (R)	V,A (R)	Q,A (R)	V,Q,A (R)	
English	205	.258	.210	.218	.263*	Q .218
Education	276	.257	.324	.324	.326	A .322
History	95	.405	.416	.387	.428	A .362
Sociology	44	.662	.637	.459	.682*	V .635
All Verbal	620	.307	.303	.290	.317	V .269
Chemistry	239	.289	.297	.326	.326	A .296
Mathematics	62	.535**	.222	.536*	.536*	Q .535
Computer Sci.	104	.290	.425**	.432	.433**	A .425
Economics	124	.208	.287**	.293	.313**	A .269
All Quant.	529	.293	.303**	.343	.344**	A .303

Note: Coefficients reflect relationships among departmentally standardized variables in samples pooled by field; data for 47 verbal departments and 53 quantitative departments were pooled.

* In this analysis, GRE-A variance is suppressed.

** In this analysis, GRE-V variance is suppressed.

In the verbal fields, except in the education sample, the validity of the verbal and quantitative composite is either approximately equal to or slightly higher than that for the verbal and analytical composite; in general, adding the third Aptitude Test score to the better pair of scores (either verbal and quantitative or verbal and analytical) does not appear to add much new information about academic performance potential (as reflected in graduate grades).

Because the three Aptitude Test scores overlap considerably with each other, elements of mutual redundancy of information clearly are present. Results of the multiple regression analysis, which have been stressed in the foregoing discussion, suggest the possibility that two (or in some cases only one) of the Aptitude Test scores may be as effective as all three scores for the purpose of forecasting first-year graduate GPA. A further indication of redundancy of information in the restructured battery may be inferred from the fact, alluded to earlier, that in a majority of the analyses (6 of 10) involving all three scores, the contribution of either the analytical or the verbal score to the optimally weighted composite was indirect, through suppression, rather than direct. A more detailed evaluation of the suppression phenomenon follows.

The suppression phenomenon*. We have noted that in certain of the analyses either the verbal or the analytical score variance is being suppressed, suggesting redundancy of information. Suppression is indicated when a variable that is positively related (or unrelated) to a criterion is negatively weighted in a regression equation when included with one or more other predictors. In analyses involving verbal, quantitative, and analytical scores (see Table 4), the analytical score is negatively weighted in the samples for English, sociology, and mathematics. The verbal score is negatively weighted in the samples for computer science, economics, and all quantitative departments. All zero-order coefficients are positive.

To consider how this is consistent with a redundancy thesis, it is useful to examine results for one of the analyses. In the combined quantitative fields analysis, for example, we see (in Table 4) that the verbal score is positively related to the graduate GPA criterion, but has a negative regression weight. This is due to a pattern of interrelationships in which a predictor whose variance is being suppressed (in this case the verbal score) is relatively strongly related to another predictor (in this case the analytical score) but is not as closely related to the criterion variable (in this case graduate GPA) as that other predictor. The relevant intercorrelation matrix for this sample is shown below:

Correlation matrix: All quantitative fields

	GRE-V	GRE-Q	GRE-A	Grad GPA
GRE-V	1.000	.347	.589	.176
GRE-Q		1.000	.448	.280
GRE-A			1.000	.303

*Suppression has been characterized as " . . . an interesting paradox of multiple correlation . . ." (McNemar, 1949, p. 163) and is interpreted more readily in statistical than in psychological terms, hence is difficult to conceptualize. There have been few appraisals of suppression effects in actual admissions contexts. However, persistent suppressor effects, which appear to reflect redundancy of information in several overlapping admissions variables have been found in several undergraduate settings (Wilson, 1974). In these settings, verbal and/or mathematical scores on the College Board Scholastic Aptitude Test acted as supressors when included in a battery with the College Board Achievement Test average (arithmetic mean of scores on three or more Achievement Tests). This latter variable seems to be a better predictor of grades in these settings than either SAT verbal or mathematical score and it includes a substantial amount of SAT-type variance.

For more detailed consideration of various aspects of the suppression phenomenon, see Conger (1974), Tzelgov and Stern (1978), Velicer (1978), and Darlington (1968).

The verbal score relates relatively closely to the analytical score (r = .589) but is less closely related to graduate GPA (r = .176) than the analytical score (r = .303). Some of the verbal score variance in the analytical score is actually redundant, even dysfunctional--a composite obtained by simply adding the verbal and analytical scores would yield a lower coefficient than that for the analytical score alone. Accordingly, elimination or suppression of an appropriate portion of the verbal related variance in the analytical score (by negatively weighting the verbal score in the regression equation) should result in increased correlation of the total composite with graduate GPA.

The negative beta weight of a suppressor variable typically is relatively small and the incremental validity associated with the suppressor usually is slight. In this case, as may be seen in Table 4, for the all quantitative fields analysis, beta weights are -.026, .184, and .236, for the verbal, quantitative, and analytical scores, respectively; and the multiple correlation for the three-score (V,Q,A) composite (R = .344) is essentially the same as that for the quantitative and analytical (Q,A) composite (R = .343), as shown in Table 5.

Thus, in this particular sample, it may be inferred that when both the verbal and analytical scores are included in the battery of predictors, there is an excess of verbal score variance. Similar inferences might be drawn regarding the analytical score, of course, in the English, sociology, and mathematics samples and regarding the verbal score in the computer science and economics samples.

Self-Reported UGPA and Its Contribution to Prediction

Analyses involving self-reported undergraduate GPA (in the major field), or SR-UGPA, could be carried out using data for 91 of the 100 departments included in the basic GRE Aptitude Test analysis reported in the previous section. Only 58 departmental samples were available for analyses involving both a self-reported UGPA and an official UGPA (referred to hereafter as a departmentally reported UGPA, or DR-UGPA). If the validity patterns for SR-UGPA approximate those observed for DR-UGPA, then the self-reported UGPA may be thought of as a useful research surrogate for a transcript-based UGPA.

Evidence bearing on the interchangeability, for research purposes, of SR-UGPA and DR-UGPA is provided in Table 6.* Shown in the columns headed SR-UGPA are validity coefficients, coefficients of multiple correlation, and corresponding beta (standard partial regression) weights for the restructured GRE Aptitude Test and SR-UGPA, generated by using data for 91 departments (41 from verbal and 50 from quantitative fields) having at least five students with a SR-UGPA. In the columns headed DR-UGPA (and SR-UGPA) are comparable statistics, generated by using data for 58 departments (28 verbal and 30 quantitative) for which both an SR-UGPA and a DR-UGPA were available for at least five students. The following patterns are noteworthy:

- The values of zero-order coefficients for SR-UGPA and for DR-UGPA in samples where both were available are almost identical.

- The pattern of beta weights for GRE Aptitude Test scores and SR-UGPA and the pattern of beta weights for GRE Aptitude Test scores and DR-UGPA in samples where both were available are very similar.

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*In examining the coefficients for GRE Aptitude Test scores in Table 6, and all subsequent tables, it is important to keep in mind that they should not be expected to correspond precisely to those reported in the basic analysis of GRE Aptitude Test scores only (e.g., Table 4 and Table 5) because of differences in the departmental composition of the respective data pools.

Table 6

Comparative Validity of a Self-Reported Undergraduate GPA (SR-UGPA) and a Departmentally Reported UGPA (DR-UGPA) for Predicting First-Year Graduate GPA

Variable	Pooled samples from verbal fields with			Pooled samples from quantitative fields with		
	SR-UGPA*	DR-UGPA** (& SR-UGPA)		SR-UGPA*	DR-UGPA** (& SR-UGPA)	
Validity coefficient						
V	.281	.271		.174	.212	
Q	.255	.242		.286	.322	
A	.275	.237		.298	.340	
SR-UGPA	.222	.195		.286	.317	
DR-UGPA	--	.200		--	.308	
Multiple correlation						
V, Q, A, SR-UGPA	.365	.339		.415	.477	
V, Q, A, DR-UGPA	--	.342		--	.442	
V, Q, (SR) or DR	(.357)	.339		(.384)	.417	
Beta weights	SR	SR**	DR**	SR	SR **	DR**
V	.145	(.163)	.159	-.024***	(-.002)***	-.004***
Q	.113	(.122)	.121	.159	(.203)	.189
A	.102	(.052)	.057	.208	(.213)	.192
SR-UGPA	.162	(.148)	--	.240	(.285)	--
DR-UGPA	--	--	.154	--	--	.226
No. departments	(41)*	(28)**		(50) *	(30)**	
N with Aptitude	586	463		507	325	
N with SR-UGPA	546	425		457	286	
N with DR-UGPA	--	409		--	307	

*Data in these columns are based on analyses employing pooled data for departments (41 from verbal fields and 50 from quantitative fields) having at least five students with a self-reported UGPA.

**Data reported are based on analyses employing pooled data for departments (28 from verbal fields and 30 from quantitative fields) having at least five students with a departmentally reported (DR) UGPA.

***GRE-V variance is suppressed in this analysis.

- The patterns of beta weights for GRE Aptitude Test scores and SR-UGPA in analyses involving data for all departments with at least five students having a SR-UGPA (41 verbal and 50 quantitative) are basically similar to the patterns observed in the analyses involving only those departments with both DR- and SR-UGPA data.

These results suggest that, for research purposes, the SR-UGPA can be considered a satisfactory surrogate for students' transcript-based UGPA.

Table 7 shows the zero-order correlation of SR-UGPA with graduate GPA in the pooled departmental samples by field. Also shown are multiple correlation coefficients for selected GRE Aptitude Test score and Aptitude Test score/SR-UGPA composites.

Several features of the data in Table 7 are noteworthy, including the following:

- In every analysis but one, the best zero-order validity coefficient (in the last column) is associated with a GRE Aptitude Test score, a pattern consistent with evidence from studies that have employed transcript-based UGPA indices (e.g., Wilson, 1979).

- With due allowance for the potential for shrinkage in the values of the multiple correlation coefficients reported, it is evident that GRE Aptitude Test scores are providing information about academic performance potential that supplements the information provided by the undergraduate grade record and vice versa.

- Illustratively, using results of analyses in the two largest samples, we see for the all verbal sample a zero-order coefficient of .222 for SR-UGPA and a multiple correlation of .358 when the verbal and quantitative scores (V,Q) are used to supplement SR-UGPA; for the all quantitative sample, comparable values are .286 (SR-UGPA) and .384 (SR-UGPA,V,Q).

These findings clearly strengthen and extend the general maxim that assessment of the academic performance potential of applicants should be improved by including both information regarding past academic performance and information from standardized admissions tests.

As for the role of the analytical ability score in strengthening the assessment process, the evidence in Table 7, like that in the previous analyses, is inconclusive.

Considering, first of all, the two largest samples--in the all verbal sample, the multiple when the analytical score is added to the battery is .365, some .007 correlation points greater than the multiple for a battery comprised of SR-UGPA, V, and Q only; for the all quantitative sample, the comparable increment in R is .031 (from .384 for the V,Q,SR-UGPA battery to .415 for the V,Q,A,SR-UGPA combination.

For the individual fields, it may be determined from Table 7 that increments in multiple correlation when SR-UGPA is added to the three Apptitude Test scores vary from .000 in mathematics to .117 in computer science.

On balance, these findings, like those reported in the previous section, suggest the tantalizing possibility of incremental validity for the analytical score in some situations, but do not provide a basis for arguing the analytical score's case on general incremental validity grounds.

GRE Advanced Test Score Validity: Limited Perspective

Only limited evidence bearing on the role of GRE Advanced Test score variance is provided by the present study. The reasons for this are suggested by an examination of the general summary information provided in Table 8 regarding patterns of data availability for GRE Advanced Test scores and related sampling considerations.

Table 7

Zero-order Correlation of SR-UGPA with Graduate GPA and Multiple Corrrelation Coefficients for Selected Aptitude and/or Aptitude/SR-UGPA Composites, by Field

Field	No. depts.	N	SR-UGPA (r)	V,Q (R)	V,Q, SR (R)	V,Q, A (R)	V,Q,A, SR (R)	Best zero-order (r)
English	(16)	194	.161	.273	.298	.280*	.305*	V .230
Education	(11)	271	.188	.268	.296	.337	.355	A .332
History	(8)	82	.378	.446	.539	.476	.557	A .411
Sociology	(6)	39	.394	.657	.723	.699*	.778*	V .652
All Verbal	(41)	586	.222	.318	.358	.329	.365	V .281
Chemistry	(20)	280	.288	.280	.390	.324	.415	A .300
Mathematics	(7)	62	.427	.535**	.613	.536*	.613**	Q .535
Computer Sci.	(10)	92	.219	.294	.335	.428**	.452***	A .428
Economics	(13)	119	.258	.251**	.356**	.318**	.396**	SR .258
All Quant.	(50)	507	.286	.296	.384	.340**	.415**	A .298

Note: These data reflect relationships in pooled samples of departmentally standardized variables. Only 91 of the 100 departments involved in the basic V,Q,A analysis could be included in the SR-UGPA analysis. Accordingly, the zero-order and/or multiple correlation coefficients for the Aptitude Test variables reported in this table are not expected to coincide exactly with those reported previously (e.g., Table 4 and/or Table 5).

*GRE-A variance is suppressed in this analysis.
**GRE-V variance is suppressed in this analysis.
***GRE-Q variance is suppressed in this analysis.

Table 8

Patterns of Data Availability and Sampling Considerations

Affecting Analysis of the Validity of GRE Advanced Test Scores

Field	GRE Aptitude Test scores available		GRE Advanced Test scores available							
	No. depts.	No. cases	No. depts.	Number of cases Apt	Adv	Mean $\bar{X}$ Adv.	Mean SD Adv.	Valid. coeff. Adv.	Best zero-order coeff.	
English	18	205	9	110	77	573	80	.348	Adv	.348
Education	12	276	2	75	28	478	59	.081	A	.381
History	10	95	6	70	50	556	65	.362	A	.427
Sociology	7	44	1	8	7	553	124	.532	Q	.649
All Verbal	47	620	18	263	162	556	75	.314	Adv	.314
Chemistry	21	239	21	239	190	659	81	.356	Adv	.356
Mathematics	7	62	4	43	35	804	106	.282	Q	.462
Computer Sci.	11	104	2	29	13	691	77	.131	A	.136
Economics	14	124	9	93	74	679	68	.239	Q	.288
All Quant.	53	529	36	404	312	681	81	.310	Adv	.310

Note: Data in table indicate, using English as an example, the total number of departmental samples in the study (18), the total number of students (205), the number of departments with five GRE Advanced Test score presenters (9), the total number of students in those departments with Aptitude Test scores (110) and Advanced Test scores (77), respectively; means of departmental Advanced Test scores means and sigmas (573 and 80, respectively); the GRE Advanced Test score validity (.348), and the best zero-order coefficient (Adv or GRE Advanced, .348). Due to differences in the samples involved, coefficients for GRE Aptitude Test scores reported in this table are not expected to coincide exactly with those reported in previous tables.

First of all, in only one field (chemistry) did all of the participating departments have at least five students with an Advanced Test score. Only 18 of 47 departments from the verbal fields had as many as five students with a GRE Advanced Test score; 36 of 53 departments from the quantitative fields met this criterion for inclusion in the Advanced Test score analysis.

Moreover, in the departments with at least five students with GRE Advanced Test scores, the number of students with Advanced Test scores was typically considerably smaller than the number with Aptitude Test scores. For example, among 263 students in 18 verbal departments with at least five Advanced Test candidates, only 162 had GRE Advanced Test scores; only 312 of the 404 students with Aptitude Test scores in 36 quantitative departments had Advanced Test scores.

The number of cases with Advanced Test scores in the respective pooled samples, by field, was quite small in most instances, ranging from 7 cases (from only one department) in sociology and 13 from two computer science departments up to the maximum of 190 students in chemistry.

Also shown in Table 8 are means of the observed GRE Advanced Test score means and standard deviations for the departmental samples, by field. For example, the nine English departments whose data were pooled had GRE Advanced Test mean scores whose average was 573; the mean of the distribution of nine Advanced Test score standard deviations for the same nine departments was 80.

It is relevant to note (although it is not reported in Table 8) that there is a moderate positive relationship between the size of the Advanced Test score validity coefficient and the mean of the departmental Advanced Test score standard deviations (rho = .465) for the eight fields. This is consistent with restriction-of-range theory.*

In the pooled all verbal and all quantitative samples, and in the English and chemistry samples as well, GRE Advanced Test scores emerge as the best single predictor. Table 9 shows simple correlations for the GRE Aptitude and Advanced Test scores by field. Also shown for the larger samples are multiple correlations for various combinations of GRE Aptitude Test scores and/or GRE Aptitude and Advanced Test scores and optimal multiple regression (beta) weights for the restructured Aptitude and Advanced Test score composites (V,Q,A,Adv).

Judging from results in the all verbal and all quantitative samples, GRE Advanced Test scores appear to be contributing unique information when added to Aptitude Test scores. In the all verbal analysis, the V,Q,A composite correlated .354 with graduate GPA as compared with a multiple of .315 for the traditional V,Q composite; when A is added to the V,Q,Adv battery, the multiple becomes .356. In the all quantitative analysis, the V,Q,Adv composite correlated .345 with graduate GPA as compared to .284 for V,Q; when A is added, the multiple becomes .366.

It is relevant to note in these two samples that when A is added to the traditional V,Q,Adv battery, incremental validity is limited. A similar observation may be made for the results in economics; in the chemistry sample, the analytical score appears to contribute some unique variance. For the English sample, the GRE Advanced Test score appears to be making a unique contribution; however, it is important to note that the incremental validity observed when A is added to the V,Q,Adv combination (.414 as opposed to .365) is associated with the quite pronounced suppression of analytical score variance, especially, but also of GRE variance.

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*See Linn, Harnisch and Dunbar (1981a) for empirical evidence of the relationship between size of validity components and sample standard deviations in a large number of law school validity-study samples.

Table 9

Simple and Multiple Correlations of GRE Aptitude and Advanced Test Scores with First-Year Graduate GPA in Pooled Departmental Samples by Field

Variable	English	Education*	History	Sociology*	All Verbal	Chemistry	Mathematics*	Computer Sci.	Economics	All Quant
Simple correlation										
GRE-V	.207	.258	.385	.619	(.281)	.188	.056	.048	.049	(.132)
GRE-Q	.141	.311	.354	.649	(.262)	.273	.462	.067	.288	(.282)
GRE-A	.074	.381	.427	.517	(.269)	.296	-.002	.136	.211	(.233)
GRE-Adv	.348	.081	.362	.532	(.314)	.356	.282	.131	.239	(.310)
Multiple correlation										
V,Q	.215	*	.426	*	(.315)	.289	*	*	.292	(.284)
V,Q,A	.239	—	.472	—	(.320)	.326	—	—	.317	(.303)
V,Q,A,Adv	.414	—	.512	—	(.356)	.420	—	—	.345	(.366)
V,Q,Adv	.365	—	.465	—	(.354)	.378	—	—	.325	(.345)
Beta weights										
V	-.130	*	.061	*	(.017)	-.037	*	*	-.155	-.077
Q	.189	—	.075	—	(.138)	.001	—	—	.198	.114
A	-.292	—	.292	—	(.054)	.247	—	—	.155	.161
Adv	.554	—	.242	—	(.227)	.309	—	—	.154	.238
No. departments	9	2	6	1	18	21	4	2	9	36
N (Aptitude)	110	75	70	7	263	239	43	29	93	404
N (Advanced)	77	28	50	8	162	190	35	13	74	312

Note: All analyses are based on pooled, departmentally standardized variables. GRE Aptitude Test score coefficients are unique to this particular analysis.

*Although multiple correlations and weights are not shown for the very small samples in these fields, data for these samples are reflected in the pooled verbal and quantitative outcomes.

On balance, these findings tend to confirm and extend the predictive utility of the respective GRE Advanced Tests. The data reviewed also point up the interpretive complications involved when data for various predictors are unevenly available.

With respect to the contribution of the analytical score, the observed results provide relatively limited prespective: Results in the two larger all verbal and all quantitative samples (which would tend to obscure possibly unique relationships in the respective fields) suggest incremental utility for the GRE Advanced Test score, but essentially none for the analytical score in the all verbal analysis and very little for the analytical score in the all quantitative analysis.

Section V: Analyses for Subgroups*

As indicated at the outset, this study was not designed to deal specifically with questions regarding the comparative validity of the restructured GRE Aptitude Test for subgroups defined in terms of sex or minority versus nonminority status. The basic analysis was based on pooled data for all first-time students without regard to subgroup membership. However, in view of the continuing interest in what has been termed "population validity," it was considered desirable to examine the relationship of the restructured GRE Aptitude Test scores (and SR-UGPA) to first-year performance in the available subgroup samples. Accordingly, separate analyses (which should be thought of as exploratory in nature) were made for minority and nonminority students and for men and women.

Data on GRE Aptitude Test scores and graduate GPA were available for a total of 103 self-designated minority students (all ethnic groups combined) and 932 self-designated White students (the nonminority sample). Slightly fewer students (96 minority and 912 nonminority) had a self-reported UGPA. For analyses by sex, GRE data were available for 757 men and 562 women; the self-reported UGPA was missing for 238 students (136 men and 102 women) who provided sex identification.**

In these subgroup analyses, all variables involved were first standardized [z-scaled--$(X - \bar{X})/sigma$], within department, based on data for all individuals with observations on each variable; z-scale transformations were made for graduate GPA, GRE Aptitude Test scores, and self-reported UGPA (SR-UGPA). Standardized scores were aggregated for analysis by field.

Mean z-scores on the variables for minorities and for women, by field, are shown in Table 10. The tabled values indicate the average amount (in departmental standard deviation units) by which the scores of the individuals involved differed from the all-student within-department means on the respective variables; negative z-score means indicate typical performance lower than that for the department as a whole and positive z-score means indicate the opposite. For example, in the pooled English department sample, the 10 minority students had negative z-score means (indicating typical standing below the all-student within-department averages) on the criterion and predictor variables: z-score means were -0.35 for graduate GPA; -0.76, -0.52, and -0.80 for verbal, quantitative, and analytical scores; and -0.13 for SR-UGPA. Among women in this field, the overall pattern was similar, but (by inference) the average difference between men and women on the variables under consideration was

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*In the basic analysis, only students identifiable as first-time graduate students were included. In the data collection process, however, restructured GRE Aptitude Test scores and graduate GPA data were obtained for about 100 additional individuals who were first-time enrollees in a given department, but not first-time graduate students in fall 1978. A decision was made to include the additional records in order to augment sample size for subgroup analyses. This decision resulted in bringing eight additional departments up to the working minimum of five cases and in slight increases in the number of cases for some departments.

**The fact that most students who provided an answer to the question on ethnic group membership also provided a self-reported undergraduate GPA, whereas a relatively large number of individuals who provided sex identification did not provide the self-reported UGPA, undoubtedly has to do with the linkage between registration for inclusion in the Locater Service and answering questions on ethnic identity and other background questions associated with that service. Sex identification, by way of contrast, is routinely asked as part of the GRE registration process for all individuals.

Table 10

Mean z-scores for Minorities and Women in Pooled Departmental Samples, by Field: Selected Variables

	Minorities						Women					
Field	(N)	Grad GPA	V	Q	A	SR-UGPA	(N)	Grad GPA	V	Q	A	SR-UGPA
English	(10)	-.35	-.76	-.52	-.80	-.13	(127)	-.07	-.14	-.23	-.09	-.01
Education	(30)	-.18	-.75	-.81	-.88	-.20	(226)	.04	-.08	-.15	-.05	.05
History	(7)	.00	-.26	-.84	-.62	.15	(43)	-.13	-.13	-.09	-.03	-.05
Sociology	(11)	-.39	-.60	-.02	-.37	-.43	(23)	.11	-.04	.02	.06	-.14
All Verbal	(58)	-.22	-.67	-.61	-.74	-.19	(419)	-.01	-.10	-.16	-.06	.01
Chemistry	(18)	-.59	-.24	-.27	-.30	-.27	(65)	-.12	.10	-.40	.07	-.08
Mathematics	(8)	-.23	-.67	-.12	-.91	-.41	(23)	-.50	-.35	-.69	-.32	-.19
Computer Science	(9)	.01	-.66	-.24	-.77	-.42	(24)	.04	-.14	-.61	-.07	-.12
Economics	(10)	-.60	-.55	-.79	-.56	-.20	(31)	.02	-.08	-.33	.01	-.07
All Quantitative	(45)	-.41	-.47	-.35	-.56	-.31	(143)	-.12	-.05	-.46	-.03	-.10

Note: All variables were converted to a standardized scale within department, based on data for the total departmental sample. The tabled values indicate the average standing of a subgroup relative to the departmental means for all students. Thus, for example, with respect to Graduate GPA, the average minority student in English was .35 standard deviations below the all-student departmental average for that variable, .76 sigmas below average on GRE-V, etc. The minorities sample includes all respondents to the question on ethnic background other than those who designated themselves as white.

considerably less than the average difference between minority and nonminority students.*

Minority students were characterized by low averages, relative to departmental "norms," on all predictor variables. In no case involving a GRE Aptitude Test score did the minority average equal or exceed the departmental average and in only one case, history, was SR-UGPA higher for minority students than for the department as a whole. These trends are consistent with expectations based on evidence of population differences. It is of some interest that, in two cases (history and computer science), the mean graduate GPA for minority students equalled the departmental average, despite rather substantially lower-than-average scores on the predictors. However, because of very small Ns, the more significant aspect of the findings is that minority students tended to be below average in performance as well as on the admissions variables under consideration. In the all verbal sample, minority students averaged approximately 0.2 sigmas below the departmental mean on graduate GPA, and for the all quantitative sample they averaged approximately 0.4 sigma units below departmental means on the performance variable.

Mean z-scores of minority students tended to be somewhat lower on the average with respect to analytical ability scores than with respect to either verbal or quantitative scores.

In most instances, the mean z-scores for women were negative, but only in the small sample from pooled mathematics departments did the magnitudes of the negative z-scores for women approach those for minorities. On the performance (graduate GPA) variable, women did slightly better than the departmental average (and men) in education, sociology, computer science, and economics. Clearly, the most substantial difference between women and men occurred in their quantitative scores--women averaged almost .5 sigma units below the departmental mean on this variable in the quantitative fields. Among the GRE Aptitude Test variables, women deviated least from departmental means in their analytical scores (and, by inference, sex differences are least pronounced on this variable).

Correlational results

Minority/nonminority. Correlation coefficients for four predictors (V, Q, A, and SR-UGPA) with respect to graduate GPA, all z-scaled prior to pooling, in minority and nonminority samples are shown in Table 11. Despite the small Ns for minority samples, it is evident that trends are quite consistent in indicating positive correlation for the GRE predictors, with magnitudes equalling or exceeding those for the nonminority samples. In the all-verbal-fields analysis (involving 58 minority students), coefficients for Aptitude Test variables were somewhat higher for minority than for nonminority students; the pattern for SR-UGPA is quite mixed, being systematically positive in the comparatively large nonminority samples, by field, but including some negative coefficients in the much smaller minority samples. Mixed negative and positive coefficients for SR-UGPA were also present in the quantitative fields for minority students, whereas all coefficients were positive for this variable in the nonminority sample.**

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*Data for the nonminority sample and for men are not shown. However, by virtue of the nature of the standardization process, it may be inferred that, if the mean deviation for a subgroup is negative, the mean deviation of its opposite in the analysis is positive, and vice versa.

**There is no reason to believe that these negative coefficients reflect other than the types of anomalies to be expected in very small samples where one aberrant (outlying) data set can drastically alter both the sign and the magnitude of an observed coefficient. Given larger minority samples, the expectation would be that SR-UGPA should behave in about the same way as is indicated in the present data for the larger nonminority samples.

Table 11

Correlation Coefficients for Predictors vs. Graduate GPA in Pooled Departmental Samples of Minority and Nonminority Students, by Field, Using Departmentally Standardized Variables

	Minority					Nonminority				
Field	(N)	V	Q	A	SR-UGPA	(N)	V	Q	A	SR-UGPA
English	(10)	.61	.68	.32	.15	(174)	.16	.17	.09	.16
Education	(30)	.36	.19	.35	-.08	(218)	.21	.18	.30	.19
History	(7)	.70	.48	.52	-.38	(84)	.29	.29	.31	.32
Sociology	(11)	.20	.29	-.01	.33	(34)	.66	.48	.24	.12
All Verbal	(58)	.40	.27	.26	.06	(510)	.23	.20	.23	.20
Chemistry	(18)	.26	.04	.22	.20	(180)	.20	.22	.23	.27
Mathematics	(8)	-.26	.75	.01	.45	(54)	.29	.48	.19	.36
Computer Science	(9)	.42	.24	.52	-.16	(84)	.17	.14	.36	.20
Economics	(10)	.08	.58	.40	-.09	(104)	.10	.19	.27	.26
All Quantitative	(45)	.10	.37	.19	.11	(422)	.17	.23	.28	.26

Note: These analyses are based on all cases providing information required to identify their ethnic-group membership. Nonrespondents to the background question on ethnicity are, therefore, excluded. The minority classification includes all groups other than self-designated white candidates who comprise the nonminority sample. The coefficients tabled are based on pooled, departmentally standardized variables.

The GRE verbal score appears to be particularly effective in the minority sample in the all verbal analysis as does the GRE quantitative score in the all quantitative analysis. In five of the eight analyses by field, the coefficient for the GRE analytical score was somewhat higher in the minority than in the nonminority sample; the same was true in six of the eight analyses for the quantitative score and in five of the eight for the verbal score. It seems reasonable to infer that the analytical score works in about the same way for minority as for nonminority students and more generally that the several predictors are certainly no less effective as potential forecasters of performance for minorities than for nonminority students.

Women/Men. Correlational results by sex are shown in Table 12. Perhaps the most noteworthy observation regarding the data is that the patterns of coefficients appear to be remarkably similar for the two sex groups. In the all verbal analyses, coefficients for verbal and analytical scores are slightly higher than the coefficient for quantitative scores in both sex groups; in the all quantitative analysis, coefficients for quantitative and analytical scores tend to be slightly higher than the coefficient for verbal scores in both groups. With respect to SR-UGPA, the coefficient for women is somewhat higher than that for men in six of the eight analyses by field, and this trend holds in the pooled verbal and quantitative analyses as well.

Incremental Validity in Broad Groupings by Field

It would be desirable to examine the interrelationships of the variables by field of study for each of the subgroups under consideration. However, it is evident that consideration of subgroups automatically results in a reduction of sample size and increases the amount of sampling error in the observed outcomes. Accordingly, even though some potentially meaningful variation may be obscured when analyses are based on broad groups of fields, it was nonetheless considered desirable to restrict multiple regression analyses of the data for subgroups to the broad verbal and quantitative classifications that have been used throughout the study.

Table 13 shows multiple correlation coefficients for selected combinations of predictors with respect to the graduate GPA criterion for (a) nonminority students, (b) minority students, (c) men, (d) women, and (e) for all students in pooled samples from departments in the four verbal fields and the four quantitative fields, respectively. Also shown is the variable with the highest zero-order coefficient. Data are presented in such a way as to indicate the change in multiple correlation when the analytical score is added to the traditional verbal and quantitative combination as well as the contribution of the self-reported undergraduate GPA when added to the restructured battery.

First of all, for minorities the data suggest relatively little incremental validity after taking into account the variable with the highest simple correlation--in these broad-field categories, either the verbal or the quantitative score would appear to be as effective as the entire set of predictors. For nonminority students, however, some evidence of incremental validity may be seen: in verbal fields, primarily for the SR-UGPA when added to the complete Aptitude Test battery, and in quantitative fields, both the analytical score and SR-UGPA appear to be contributing uniquely to the improvement of validity when added successively to the traditional verbal and quantitative combination. Among men in verbal fields, adding the analytical score to the verbal and quantitative combination does not lead to a notable increase in multiple correlation, and the further addition of SR-UGPA contributes only slightly. For women in verbal fields, the verbal, quantitative, and analytical combination is a bit better than verbal and quantitative scores; SR-UGPA appears to be contributing potentially useful unique information regarding performance potential when added to the restructured battery.

In the quantitative fields, for both sex groups, the multiple correlation (R) increases with the addition of the anlytical score and again with the addition of SR-UGPA. It is of incidental interest to note that the multiples for women tend to

Table 12

Correlation Coefficients for Predictors vs. Graduate GPA in Pooled Departmental Sample of Men and Women, Using Departmentally Standardized Variables: By Field

	Men					Women				
Field	(N)	V	Q	A	SR-UGPA	(N)	V	Q	A	SR-UGPA
English	(102)	.18	.10	.05	.04	(127)	.20	.35	.20	.27
Education	(75)	.19	.21	.31	-.07	(226)	.24	.17	.26	.24
History	(69)	.33	.24	.33	.30	(43)	.38	.41	.48	.30
Sociology	(32)	.60	.47	.39	.25	(23)	.52	.15	.27	.30
All Verbal	(278)	.26	.19	.22	.10	(419)	.26	.25	.27	.25
Chemistry	(199)	.20	.21	.27	.31	(65)	.27	.16	.40	.21
Mathematics	(58)	-.02	.31	.12	.36	(23)	-.06	.48	-.07	.49
Computer Science	(104)	.13	.14	.29	.12	(24)	.50	.41	.56	.49
Economics	(118)	.16	.28	.35	.19	(31)	-.04	.07	.14	.25
All Quantitative	(479)	.15	.23	.28	.24	(143)	.21	.26	.31	.31

Note: All variables were converted to a standard (z-scaled) form prior to pooling. Z-scaling was done within each department, using data for all individuals with observations on a variable. The departmentally standardized data were pooled by field and the values tabled reflect the observed correlations.

Table 13

Multiple Correlation for Selected Combinations of Predictors With Respect to Graduate GPA for Subgroups in Primarily Verbal and Primarily Quantitative Fields

Group : Field	Combination of predictors			Highest zero-order coefficient
	V,Q (R)	V,Q,A (R)	V,Q,A & SR-UGPA (R)	
Nonminority: Verbal	.260	.270	.307	V .228
Minority : Verbal	.414	.416*	.417*	V .401
Nonminority: Quant	.246	.302	.375	A .283
: Quant	.368	.372**	.373**	Q .366
Men : Verbal	.271	.274	.284	V .259
Women : Verbal	.306	.315	.365	A .267
Men : Quant	.239	.302**	.361**	A .281
Women : Quant	.301	.348	.439**	A .311
All students: Verbal	.284	.293	.326	V .254
All students: Quant	.260	.316**	.380**	A .285

Note: These analyses are based on combined samples from verbal fields (English, education, history, sociology) and quantitative fields (chemistry, mathematics, computer science, economics). All are based on z-scaled variables (within department) prior to pooling.

* GRE-A variance is suppressed in this combination.

** GRE-V variance is suppressed in this combination.

be higher than those for men and that those for minorities (represented, it should be remembered, by very small samples from the respective fields) tend to be somewhat higher than those for nonminorities, especially in the verbal fields.*

On balance, incremental validity appears to be associated with the analytical score and SR-UGPA in quantitative fields, but primarily with SR-UGPA in verbal fields. Obviously it must be remembered that verbal and quantitative scores and very likely an actual UGPA were employed in screening whereas analytical scores (if instructions were followed) were not directly evaluated in screening candidates for admission. Thus, the analytical score enjoys a potential advantage in any analysis of this type because its range has not been restricted due to direct selection. It is also important to keep in mind, as suggested earlier, that the broad field classifications tend to obscure potential effects that might be observed given adequate data for individual fields of study.

Performance Relative to Expectation Based on GRE Scores: An Exploratory Analysis

It is believed that the correlational results that have been reviewed permit a rather strong inference that the correlational validity of the GRE Aptitude Test probably is quite comparable for minority and nonminority students, and for men and women. These correlational results, derived from pooled data samples for the respective subgroups, are consistent with evidence generated in numerous studies in undergraduate and professional school settings (e.g., Breland, 1978; Linn, 1975; Schrader and Pitcher, 1976; Wilson, 1980, 1981).

Using data from relatively large samples of entering students in each of several colleges or law schools, investigators in these settings have been able to answer questions regarding not only the correlational validity of a set of standard admissions measures for various subgroups, but also the extent to which the observed average level of academic performance of members of a subgroup is consistent with expectation based on scores on the admissions measures. Results of these studies suggest that a defensible procedure for generating estimates of expected performance is to use a regression equation based on data for all students. However, investigations of the comparative performance of subgroups in these settings have been context-specific; that is, they have not used pooled data.

It should be apparent that the data at hand for these subgroups of graduate students do not permit context-specific comparisons and thus provide only a very limited basis for examining questions of comparative performance (e.g., grades relative to expectation based on GRE scores). However, an assessment of observed trends in these data may suggest directions for future investigation and provide some basis for informed speculation about how subgroups may be performing relative to expectation based on GRE Aptitude Test results.

By inspecting the z-score means in Table 10, for example, it is possible to identify samples of minorities or women in which observed performance (z-scaled GPA mean indicating deviation from departmental GPA means in departmental standard deviation units) appears to be inconsistent with expectation (given the average deviation in sigma units from departmental means on the Aptitude Test).

In the comparatively large sample of women in education, for example, despite negative z-score means on the GRE Aptitude Test variables, the mean z-score for graduate GPA is slightly above average (.04 sigma units); similarly, though the sample is much smaller, women in computer science with a mean graduate GPA z-score of

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*It is important to note that either analytical or verbal variance is being suppressed in several of these subgroup analyses, a pattern that was observed in the basic analyses based on data for all students (see Table 5 and related discussion).

0.04 appear to be performing better than expected, given their consistently negative z-scores on the Aptitude Test variables.

For minority students in two very small pooled samples (seven in history, and nine in computer science), the observed mean graduate GPA z-scores of 0.00 and 0.01, reflecting essentially average performance, are associated with rather markedly negative standings on the respective GRE predictors.

These particular instances of observed performance that is not consistent with standing on GRE scores reflect trends in very limited samples, and the results should not be overemphasized. By looking a bit more systematically at trends for the two broad classifications of fields (i.e., the all verbal and the all quantitative samples, however, it may be possible to obtain a somewhat better, but obviously still quite limited, perspective on the question of performance relative to expectation based on GRE scores.

The data provided in Table 14 reflect the results of a comparison of observed z-score means for graduate GPA with expected z-score means for minorities, women, and men in the all verbal and all quantitative samples. Expected z-score graduate GPA means for subgroups in the all verbal sample were based on a regression equation developed by using data for all students in verbal fields (including students who could not be classified with respect to subgroup membership) and in the quantitative fields analyses a similarly developed regression equation for combining GRE Aptitude Test scores was used.

For the minority sample in verbal fields, the observed graduate GPA z-score mean of -0.22 was essentially consistent with the mean expected z-score of -0.24; however, in quantitative fields, minority students averaged more than four-tenths of a standard deviation below departmental GPA means (mean z-score = -0.41), while on the basis of their GRE scores (using the general quantitative-sample equation) their expected standing was considerably higher (mean z-score = -0.17).

For women in verbal fields, observed standing was slightly higher than expected, while the opposite was true for them in the quantitative fields. For men in verbal fields, observed GPA standing was slightly lower than expected, while they did slightly better than expected in the quantitative fields.

The only discrepancy that appears to be relatively pronounced is that observed for minority students in the quantitative fields. The observed z-scaled graduate GPA mean (-0.41) was considerably lower than the estimate (-0.17) based on GRE scores as combined, using the total sample, all-quantitative-fields regression equation applicable to z-scaled GRE scores.

These findings suggest possible directions for inquiry but they clearly do not provide a basis for conclusions. They point to the urgent need for the development of studies designed to deal specifically with questions regarding the comparative performance of subgroups.

Table 14

Observed Performance (Mean z-score on Graduate GPA) Compared to that Expected from Scores on the GRE Aptitude Test, Using a Total-Sample Regression Equation, for Subgroups in Verbal and Quantitative Fields

Field/ Subgroup	(N)	z-score mean on GRE*			z-score mean on Grad GPA*	
		GRE-V	GRE-Q	GRE-A	Observed	Expected**
All verbal						
Minority	(58)	-0.67	-0.61	-0.74	-0.22	-0.24
Women	(419)	-0.10	-0.16	-0.06	-0.01	-0.04
Men	(8)	0.15	0.25	0.09	0.02	0.06
All quantitative						
Minority	(45)	-0.47	-0.35	-0.56	-0.41	-0.17
Women	(143)	-0.05	-0.46	-0.03	-0.12	-0.07
Men	(479)	0.02	0.14	0.01	0.03	0.02

*Mean deviation from departmental means in departmental sigma units.

**Expected z-score mean for the all verbal subgroups was based on a regression equation developed using data for all students in verbal fields with predictor and criterion data, including students who could not be classified with regard to subgroup membership, and expected z-score mean for the all quantitative subgroups used a similarly developed all quantitative regression equation. Standard partial regression weights were as follows:

[Verbal equation] .16 V + .10 Q + .10 A = Estimated z-score verbal

[Quantitative equation] -.05 V + .15 Q + .25 A = Estimated z-score quant

Section VI. Concluding Observations

The evidence that has been reviewed indicates clearly that the restructured GRE Aptitude Test, like its predecessor, provides information of value for predicting first-year performance in graduate study and that this information usefully supplements that provided by the undergraduate academic record.

Because of (a) its relatively close relationship (correlations at the .7 level) with the verbal and quantitative measures, whose predictive value had been firmly established, and (b) its demonstrated relationship with self-reported undergraduate grade-point average, the analytical score was expected from the outset to have predictive validity resembling that of the verbal and quantitative scores (ETS, 1977). The evidence provided by this study suggests strongly that this particular expectation was well grounded. For example (from Table 3):

- In three of four fields designated as quantitative (all but mathematics), observed validity coefficients for the analytical score were slightly higher than those for the quantitative score (and values for both quantitative and analytical scores were higher than those for the verbal score.

- In the verbal fields, the observed pattern of coefficients for Aptitude Test scores was not consistent. In the comparatively large pooled education sample, the analytical score came out ahead in the correlational competition with the verbal and quantitative scores GRE-Q; in history, the value for analytical paralled that for verbal (in the .30 range); in sociology the analytical coefficient (in the .30 range) was substantially overshadowed by an atypically high verbal coefficient (in the .6 range); and, in English, the analytical score was only weakly associated with first-year GPA (in the .10 range) but so was the verbal score (in the .20 range, a value considerably lower than that estimated for pooled English samples in the Cooperative Validity Studies Project [Wilson, 1979].

- Findings for the two broad classifications of fields suggest that, in the all verbal fields analyses, the validity coefficient for the analytical score tended to parallel those for the verbal and quantitative scores, and in the all quantitative fields analyses validities for the analytical and quantitative scores were comparable.

While the evidence reviewed in this study confirms rather clearly the a priori expectation of predictive utility for the analytical measure, per se, it must be characterized as quite inconclusive with respect to questions regarding the extent to which information provided by the analytical score might supplement that provided by the verbal and quantitative scores, and/or whether the analytical measure might prove to be of supplemental value generally or only in specific fields of study.

First, to iterate for the last time a point that has been made repeatedly throughout this report because of its importance, during the period in which the students in this study were applying for admission to graduate school, schools and departments were advised by the GRE Program not to consider analytical scores pending the collection of evidence regarding their predictive validity in graduate school settings. Assuming that this advice was followed, observed coefficients for verbal and quantitative scores would be attenuated due to direct selection whereas the coefficients for analytical scores would be affected by indirect selection only. Thus, analytical scores entered this particular postselection correlational competition with something of an advantage, and all comparative analyses are to some extent biased in favor of this new measure.

Second, elements of mutual redundancy of information are introduced when the three Aptitude Test scores are treated as a battery (see Table 5 and related discussion). For example, in 6 of 10 regression analyses involving various combinations of Aptitude Test scores, the contribution of either the verbal or the analytical score

to the optimally weighted composite was indirect, through suppression, rather than direct. In three of the analyses (English, sociology, mathematics), analytical variance was suppressed, while in the three others (computer science, economics, and the all quantitative fields sample), verbal variance was suppressed.

Given these circumstances, the evidence regarding incremental validity associated with the new analytical score and evidence regarding the relative contribution to prediction of the three Aptitude Test scores when they are treated as a battery does not provide a basis for firm conclusions.

Generally speaking, in the primarily quantitative fields, a quantitative-analytical composite appeared to be better than a verbal-quantitative composite, and the multiple correlation (with graduate grades) of quantitative and analytical scores only tended to be about as great as the multiple for all three Aptitude Test scores. On the other hand, in the verbal fields, except for education, validities of verbal-quantitative composites were either approximately equal to or slightly higher than those for combined verbal and analytical scores.

On balance, findings of this nature suggest that the analytical score may tend to be more effective in the quantitative than in the verbal areas under consideration. However, it is perhaps most useful to consider the observed findings as an initial reference point whose interpretive value will be enhanced when viewed in the light of subsequent validation research. Replication involving samples from the same set of fields as that involved in the present study would be highly useful. Would we see, for example, in a second set of chemistry, computer science, and economics samples, the predictive advantage observed for the analytical measure in the present samples?

It seems quite important to make an active effort to encourage the early participation of departments from the eight fields involved in the present study in the regularly scheduled GRE Validity Study Service in order to facilitate replication.

In general, it is important to recognize the analytic potential, especially in graduate level validation research, of pooled within-group (within-department) matrices of predictor-criterion intercorrelations. Given procedures that generate comparable data sets from a representative sample of small departments within each of the major disciplinary groupings on a planned, systematic basis, marked progress might be made in resolving questions such as those under consideration in this study.

The value of such pooling procedures has been demonstrated in a variety of ways in this study. Further exploration of the assumptions underlying these procedures clearly is in order, but they have provided a basis for generating useful information regarding the correlational validity of GRE scores by employing data for a large number of samples, no one of which individually could support an "interpretable" validity study.

Finally, results of the exploratory subgroup analyses provide evidence suggesting that the correlational validity of GRE Aptitude Test scores is at least as great for minority as for nonminority students and is comparable for men and for women. Limited evidence has been provided regarding the performance of subgroups relative to expectation based on GRE scores using a general equation in analyses clearly thought of as exploratory in nature. Additional studies involving subgroup prediction are needed.

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APPENDIX A

A-1 Letter of invitation to participate in the study

A-2 Overview of study procedures

A-1

Graduate Record Examinations Board
PRINCETON, NEW JERSEY 08541 ● AREA CODE 609 921-9000

IN AFFILIATION WITH
The Association of Graduate Schools
The Council of Graduate Schools

1978-79
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University of Virginia
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University of Cincinnati

Bernard V. Khoury
Secretary to the Board

Dear Colleague: January 22, 1979

As you know, the GRE Aptitude Test recently was revised to include a measure of analytical ability in addition to the measures of verbal and quantitative abilities. Empirical evidence is needed regarding the correlation of scores on the restructured Aptitude Test with performance of first-year graduate students from a representative array of disciplines. On behalf of the Graduate Record Examinations Board, I hope that several departments from your graduate school will be able to participate in a special cooperative study designed to assess the predictive validity of the restructured Aptitude Test in samples of graduate students who began their studies in fall, 1978.

By way of background, I enclose a report of cooperative validity studies recently completed for 39 graduate schools, involving analysis of data for from one to 17 departments per school. These studies provide evidence consistent with that from earlier studies indicating that GRE Aptitude and Advanced Tetts, and Undergraduate GPA, correlate positively with first-year performance in a variety of departments and disciplines.

The studies summarized in the accompanying report were carried out before the Aptitude Test was restructured and the measure of analytical ability was added. Questions regarding the validity of the restructured Aptitude Test are the focus of this special research effort. By participating in this special study, your school will also become a participant in the new GRE Validity Study Service offered for the first time this spring. No duplication of effort will be involved. Most of the data needed to conduct studies will come directly from the GRE Program file of test data on candidates. All participants will receive reports of findings for their own graduate departments as well as a general summary of findings from the special study.

After reviewing the proposed study procedures and the schedule of activities, please complete the Participation Reply Form, enclosed, and return it to Educational Testing Service in the prepaid business reply envelope by February 16, 1979. Again, we hope that several of your graduate departments will be able to participate in this special study.

Sincerely yours,

Donald J. White

cc: Bernard V. Khoury, Program Director
Graduate Record Examinations

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A-2

(1 of 3 pages)

STUDY OF THE PREDICTIVE VALIDITY OF THE RESTRUCTURED

GRE APTITUDE TEST

Overview of Definitions, Procedures and

Schedule of Activities, 1978 - 1979

Focus of the proposed study is to be on departmental samples from the following fields:

English	Economics	Sociology	Chemistry
History	Education	Computer Science	Mathematics.

Priority should be given to departments in these fields, but departments in other fields may participate in the study.

The population of interest is first-time graduate students, enrolled in a degree program, and classifiable as full-time students.

The cohorts or samples to be studied consist of all such students who entered in Fall 1978, who also presented GRE Aptitude Test scores. At least 10 of these students should have scores on the restructured Aptitude test (i.e., should have taken the test in October 1977, or later).

Both prospective master's and prospective doctoral students may be included in a departmental sample provided first-year programs and evaluation procedures are roughly comparable for both.

The performance or criterion measure to be studied is the first-year graduate grade point average or some other index of attainment during the academic year 1978-1979 such as, for example, a standard faculty rating.

Basic predictor variables will be GRE-Verbal, GRE-Quantitative, and GRE-Analytical scores. Departments are encouraged to provide an optional predictor, namely, an Undergraduate GPA, if available.

Study Procedures

By returning a Participation Reply Form (PRF), enclosed, graduate schools may indicate their intention to participate or not to participate in the proposed study. Schools interested in participating may designate on the PRF one or more departments as potential participants. For each participating department, the following steps are involved:

(2 of 3 pages)

Step I. ETS sends to the graduate school a PROSPECTIVE APPLICANT ROSTER for each department--i.e., an alphabetical listing of GRE-test takers who asked to have their score reports forwarded to that department during the 1977-78 admissions year. *

Step II. On each Prospective Applicant roster, the graduate school will indicate the individuals who entered in fall, 1978, as first-time enrolled, full-time, graduate students.

Step III. Graduate schools return the rosters with basic sample identification to ETS. ETS looks up GRE scores and other preadmissions data needed for the study from a file of data supplied by candidates for research purposes when they took the GRE tests. An edited VALIDITY STUDY ROSTER containing names of members of the validity study sample for each department will be prepared by ETS.

Step IV. Near the end of the academic year, 1978-79, Validity Study Rosters will be fowarded to participating graduate schools. On these Validity Study Rosters, graduate schools will be asked to provide

a) a first-year graduate GPA and/or some other index of first-year performance for each student; and, optionally

b) an undergraduate GPA.

During this step, questions regarding missing predictor data and sample definition, if any, can be resolved.

Step V. Graduate schools return completed Validity Study Rosters to ETS. ETS processes and analyzes the data, department by department, and prepares individualized reports for each cooperating department in each graduate school. Summaries of findings for all departments will subsequently be distributed to all participants.

Schedule of Activities

Target date for completion	Activity
February 16, 1979	Graduate schools return Participation Reply Forms
March 15, 1979	ETS submits Prospective Applicant Rosters
April 15, 1979	Graduate schools return Prospective Applicant roster with sample identification

*About half of the participating schools followed a modified procedure involving (a) their initial submission of a roster of first-time enrollees with ETS lookup of admissions scores and (b) their later provision of first-year graduate GPA for the students involved.

(3 of 3 pages)

June 1, 1979	ETS sends Validity Study Rosters to graduate schools for collection of first-year grade point average plus (optional) predictor and/or criterion data on each student.
August 6, 1979	Graduate schools return completed Validity Study Roster to ETS.

If there are questions about the study procedures, please write or call collect, as follows:

Kenneth M. Wilson 609-921-9000, extension 2391
R-208
Educational Testing Service
Princeton, NJ 08541

APPENDIX B

Preliminary Report to Participating Graduate Schools

STUDY OF THE VALIDITY OF THE RESTRUCTURED
GRE APTITUDE TEST, 1978-79*

Educational Testing Service
Princeton, NJ 08541

To: Study Participants Date: February, 1980**

From: Kenneth M. Wilson

Subject: Summary of Preliminary Findings: An Interim Report

As of the date of this interim report, standard statistical analyses have been completed, in cooperation with the GRE Validity Study Service, for all departments participating in the study.

The analyses have generated correlation coefficients indicating the relationship of scores on the restructured GRE Aptitude Test (and certain other predictors, as available) to first-year Graduate GPA in samples of first-time enrolled graduate students from departments in eight fields. Only students entering in fall 1978 were included. The Graduate GPA criterion is based on work completed during the academic year 1978-79.

Graduate schools (N = 36) with one or more departmental samples represented in the study are listed in Table 1.

Table 2 shows the number of departmental samples with data in each of the eight fields designated for the study (English, history, sociology, education--or verbal fields; economics, mathematics, chemistry, computer science--or quantitative fields). Correlation coefficients were computed for a predictor-criterion set when data were available for five or more students.

As shown in Table 2, GRE Aptitude scores (verbal, quantitative, and analytical) were available for analysis in 100 samples, 47 from departments in verbal fields and 53 from departments in quantitative fields. GRE-Advanced test scores (appropriate to field) were available for five or more students (who also had a Graduate GPA) in only 54 samples; the undergraduate grade point average of record (UGPA) could be analyzed in 62 samples and a self-reported UGPA (reported by candidates when they took the GRE tests) was available for five or more students in 91 of the 100 samples. Sample size was extremely small (see mean size of sample in Table 2).

It is important to keep in mind that coefficients based on any one of the very small departmental samples do not provide reliable estimates of predictor-criterion correlations. However, by observing trends in coefficients over a relatively large number of samples, and by pooling

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*Sponsored by the Graduate Record Examinations Board.

**Updated 11/5/80

data from departments in the same field, meaningful inferences regarding predictor-criterion relationships can be drawn (Wilson, 1979).[1]

In this context, we are now able to provide preliminary estimates of correlational validity coefficients for the respective predictors with regard to a common, first-year GPA criterion based on pooled data. More specifically, the pooled estimates shown in Table 3 indicate the predictor-criterion correlation obtained for the total number of students in several similar departments (e.g., several English departments) when all variables were standardized within each department prior to pooling.[2]

In evaluating the estimated coefficients for the three aptitude scores in Table 3, it is important to note that all graduate schools and departments were asked by the GRE program not to consider the GRE-Analytical score in admissions, pending the collection of empirical evidence regarding its validity. When a variable is considered directly in the selection process, the range of scores among enrolled students is reduced and there tends to be a corresponding restriction on the correlation between that variable and a performance criterion. Thus, GRE-Analytical enjoys some "advantage" by not having been directly involved in the selection process.

Data for the restructured GRE-Verbal and GRE-Quantitative, GRE-Advanced, and UGPA, shown in Table 3, were combined with data for these predictors as developed during the GRE Cooperative Validity Studies Project.[3] The resulting pooled estimates of validity shown in Table 4, like those in Table 3, are based on variables standardized within department.

Multiple regression analyses based on pooled data have not been completed. Accordingly, questions regarding the relative weighting of GRE-V, GRE-Q, and GRE-A cannot be addressed directly at this time. Analyses concerned with incremental correlational validity, relative weighting, and suppression

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[1] Wilson, K. M. The validation of GRE scores as predictors of first-year performance in graduate study: Report of the GRE Cooperative Validity Studies Project, GREB No. 75-8R. Princeton, N.J.: Educational Testing Service, 1979.

[2] Since the relationship between GRE scores and grades tends to be positive in samples differing markedly in mean level of GRE scores, it may be inferred that these coefficients are lower than would be observed if all students in the pooled samples were "competing" for grades in one large department.

[3] GRE-A scores, of course, were not available for students included in the earlier studies, since this test was first administered in October 1977.

effects (e.g., negative multiple regression weight for a predictor with a positive correlation with the criterion) will shed useful light on the role of GRE-Analytical ability scores relative to the other measures.

It is of incidental interest to note that the correlational validity coefficients for self-reported UGPA tend to parallel, roughly, those for the university reported UGPA, suggesting a potentially useful research role for the self-report variable. Evidence generated in analyses involving the self-reported UGPA may provide a basis for inferences about the "official" UGPA (which may not be computed systematically in all admissions contexts).

Departmental Findings

Findings for your graduate school are attached as Exhibit 1.[4]

Findings reported for each departmental sample include (a) the correlation between each predictor and the Graduate GPA criterion (and other criterion variables, if provided), (b) the minimum and maximum value for each variable, (c) the arithmetic mean and the standard deviation for each variable, and (d) the number of students with observations on each variable. The N reported for the Graduate GPA (or other criterion variable) represents the maximum N for any correlation coefficient reported. In assessing findings for the department(s) from your graduate school, it is quite important to keep the following considerations in mind:

- The predictor-criterion correlation coefficients reported in the column headed "r" (handwritten) may be based on as few as five cases, and simply describe the nature of covariation between pairs of observations in a very small sample.

- The underlying relationship between GRE scores or undergraduate grades and first-year graduate grades (or other criteria of successful performance in graduate study) is expected to be positive. This is supported by the summary findings in Tables 3 and 4, evidence from previous correlational validity studies in academic settings, and evidence of the positively interrelated organization of human abilities generally.

- Negative correlations between academic predictors and academic criterion variables may occur due to sampling fluctuation in very small samples such as those involved in these studies.

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[4] For departments with Ns greater than 10 for any predictor-criterion set, the GRE Validity Study Service is preparing a detailed report of findings.

- One atypical (outlying) data set can markedly influence both the magnitude and the sign of a coefficient in a small sample. It is quite important, therefore, to keep in mind that because of the very small samples involved, inferences regarding the relative usefulness of different predictors should not be drawn from the individual departmental findings reported in Exhibit 1.

Results of additional analyses based on pooled data will be forwarded in a later report.

ILLUSTRATIVE COPY: DEPARTMENTAL DATA

12/10/79

GRADUATE RECORD EXAMINATIONS
VALIDITY STUDY SERVICE

EXHIBIT 1

INSTITUTION: UNIVERSITY OF
DEPARTMENT: ENGLISH
ADD. DESCR.: RESTRUCTURED APTITUDE VALIDITY
SUBGROUP: TOTAL

TABLE 4

SUMMARY STATISTICS FOR INDIVIDUAL VARIABLES

VARIABLE	r	MINIMUM OBSERVED	MAXIMUM OBSERVED	MEAN	STANDARD DEVIATION	NUMBER OF STUDENTS
GRE VERBAL	.56	350	690	537.0	102.4	10
GRE QUANTITATIVE	.68	290	570	458.0	108.6	10
GRE ANALYTICAL	.71	290	690	543.0	131.4	10
UNDERGRADUATE GPA	.78	2.50	3.89	3.252	0.429	10
OPTIONAL PREDICTOR SELF REPORTED UGPA	.36	5.	7.	6.1	0.9	9
GRADUATE FIRST-YEAR GPA		2.88	4.00	3.624	0.350	10

Table 1

Graduate Schools Participating in the Restructured Aptitude Validity Study: Data for the Academic Year 1978-79

University of Oklahoma	San Diego State University
Texas Technological University	Colorado State University
University of Iowa	University of Massachusetts
Louisiana State University	University of Rochester
Iowa State University	University of Pittsburgh
Texas A&M University	University of Pennsylvania
University of Virginia	Syracuse University
University of North Carolina	SUNY at Stony Brook
University of Maryland	SUNY at Albany
University of Florida	Wayne State University
University of Central Florida	University of Wisconsin
Florida State University	University of Tennessee
University of Washington	University of Notre Dame
University of Southern California	University of Cincinnatti
University of Colorado (Boulder)	Ohio State University
University of San Diego	Northwestern University
University of California (Davis)	Loyola University of Chicago
Washington State University	Jackson State University

TABLE 2

NUMBER OF DEPARTMENTAL SAMPLES FROM EIGHT BASIC STUDY FIELDS SUPPLYING DATA FOR AT LEAST FIVE STUDENTS WHO EARNED A FIRST YEAR GRADUATE GPA AND WHO HAD SCORES ON A DESIGNATED STANDARD PREDICTOR

FIELD	NO. OF DEPARTMENTS					MEAN SIZE OF SAMPLE			
	IN STUDY	GRE-APT	GRE-ADV	UGPA	S-RPT UGPA	GRE-APT	GRE-ADV	UGPA	S-RPT UGPA
ENGLISH	18	18	9	12	16	11.4	8.6	10.5	11.1
HISTORY	10	10	6	7	8	9.5	8.3	10.3	10.0
SOCIOLOGY	7	7	1	4	6	6.3	7.0	6.2	6.3
EDUCATION	12	12	2	8	11	23.0	14.0	25.2	22.8
ECONOMICS	14	14	9	8	13	8.8	8.4	8.9	8.2
MATHEMATICS	7	7	4	3	7	8.9	8.8	8.3	8.6
CHEMISTRY	21	21	21	13	20	11.4	9.0	11.9	10.0
COMPUTER SCIENCE	11	11	2	7	10	9.5	6.5	8.7	9.1
ALL VERBAL	47	47	18	31	41	13.2	9.0	13.7	13.3
ALL QUANTITATIVE	53	53	36	31	50	10.0	8.7	10.1	9.1

NOTE: ALL DEPARTMENTS IN THE STUDY HAD AT LEAST FIVE STUDENTS WITH SCORES ON THE RESTRUCTURED GRE APTITUDE TEST AND A FIRST YEAR GRADUATE GPA. HENCE GRE APTITUDE ANALYSES COULD BE COMPLETED FOR ALL PARTICIPATING DEPARTMENTS. HOWEVER, WITH RESPECT TO THE OTHER PREDICTORS UNDER CONSIDERATION, PREDICTOR-CRITERION SETS FOR FIVE OR MORE STUDENTS WERE NOT AVAILABLE FOR ALL PARTICIPATING DEPARTMENTS. THUS, FOR EXAMPLE, SCORE ON GRE ENGLISH AND A FIRST YEAR GPA WERE AVAILABLE FOR ONLY 9 DEPARTMENTS, 12 DEPARTMENTS HAD FIVE STUDENTS WITH AN "OFFICIAL" UNDERGRADUATE GPA AND A FIRST-YEAR GRADUATE GPA, ETC.

TABLE 3

VALIDITY COEFFICIENTS FOR GRE APTITUDE (RESTRUCTURED), ADVANCED, AND UGPA, VERSUS FIRST YEAR GRADUATE GPA, ESTIMATED USING DEPARTMENTALLY STANDARDIZED DATA IN POOLED DEPARTMENTAL SAMPLES

FIELD	VALIDITY COEFFICIENT						N PER COEFFICIENT			
	GRE-V	GRE-Q	GRE-A	GRE-ADV	UGPA	S-PRT UGPA	GRE-APT	GRE-ADV	UGPA	S-PRT UGPA
ENGLISH	.209	.225	.136	.348	.210	.173	205	77	126	177
HISTORY	.352	.325	.363	.362	.318	.379	95	50	72	80
SOCIOLOGY	.637	.455	.327	.532	.281	.394	44	7	25	38
EDUCATION	.226	.208	.320	.080	.184	.187	276	28	202	251
ECONOMICS	.080	.208	.269	.239	.388	.259	124	76	71	106
MATHEMATICS	.210	.536	.193	.280	.441	.429	62	35	25	60
CHEMISTRY	.187	.273	.296	.355	.270	.289	239	190	155	200
COMPUTER SCIENCE	.244	.233	.425	.131	.370	.219	104	13	61	91
VERBAL FIELDS*	.269	.249	.266	.314	.220	.225	620	162	425	546
QUANTITATIVE FIELDS**	.176	.281	.303	.310	.330	.286	529	314	312	457

NOTE: DATA ARE FOR FIRST-TIME ENROLLED GRADUATE STUDENTS ENTERING IN FALL 1979. COEFFICIENTS ARE BASED ON POOLED, DEPARTMENTALLY STANDARDIZED DATA. UGPA IS THE UNDERGRADUATE GRADE POINT AVERAGE CALCULATED BY A DEPARTMENT; S-PRT UGPA IS A UGPA SELF-REPORTED BY GRE CANDIDATES.

*ENGLISH, HISTORY, SOCIOLOGY, EDUCATION

**ECONOMICS, MATHEMATICS, CHEMISTRY, COMPUTER SCIENCE

TABLE 4

VALIDITY COEFFICIENTS ESTIMATED USING DEPARTMENTALLY STANDARDIZED VARIABLES IN POOLED DEPARTMENTAL SAMPLES: DATA FOR FIRST-TIME STUDENTS IN 1974-75 AND 1978, RESPECTIVELY

FIELD/YEAR		Validity coefficient						Size of pooled sample			
		GRE-V	GRE-Q	GRE-A	GRE-ADV	UGPA	S-Rpt UGPA	GRE-Apt	GRE-ADV	UGPA	S-Rpt UGPA
English	74-5	.41	.24		.48	.22		190	122	144	
	78	.21	.22	.14	.35	.21	.17	205	77	126	80
	74-5-8	.30	.23	.14	.43	.22	.17	395	199	270	80
History	74-5	.31	.26		.21	.30		348	160	284	
	78	.35	.32	.36	.36	.32	.38	95	50	72	80
	74-5-8	.32	.27	.36	.24	.30	.38	443	210	356	80
Sociology	74-5	.43	.30		.54	.55		287	43	146	
	78	.64	.46	.33	.53	.28	.39	44	7	25	38
	74-5-8	.46	.32	.33	.54	.51	.39	331	50	171	38
Education	74-5	.18	.12		.54	.24		292	59	332	
	78	.23	.21	.32	.08	.18	.19	276	28	202	251
	74-5-8	.20	.16	.32	.39	.22	.19	568	87	534	251
All Verbal Fields	74-5	.32	.23		.38	.31		1117	384	906	
	78	.27	.25	.27	.31	.22	.22	620	162	405	546
	74-5-8	.30	.24	.27	.36	.28	.22	1737	546	1331	546
Economics	74-5	.09	.34		.45	.27		204	110	125	
	78	.08	.21	.27	.24	.39	.26	124	76	71	196
	74-5-8	.09	.29	.27	.37	.31	.26	328	186	196	106
Mathematics*	74-5	.32	.23		.35	.30		154	34	32	
	78	.21	.54	.19	.28	.44	.43	62	35	25	60
	74-5-8	.29	.32	.19	.31	.36	.43	216	69	57	60
Chemistry	74-5	.09	.31		.39	.31		389	219	419	
	78	.19	.27	.30	.36	.27	.29	239	190	155	200
	74-5-8	.13	.30	.30	.37	.30	.29	628	409	574	200
Computer Science	78*	.24	.23	.42	.13	.37	.22	104	13	61	91
All Quantitative Fields	74-5	.14	.30		.40	.31		747	363	576	
	78	.18	.28	.30	.31	.33	.29	529	314	312	457
	74-5-8	.15	.29	.30	.36	.31	.29	1276	677	888	457

NOTE: Data for 1974 & 1975 entrants are from the Cooperative Validity Studies (Wilson, 1979, p. 21).

* In analyses for 1974-5, computer science departments were included under Mathematics.

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